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Volume 25 Number 3

BULLETIN
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MARCH, 1941

OIL IN INTERNATIONAL RELATIONS[1]

WALTER H. VOSKUIL[2]
Urbana, Illinois

ABSTRACT

The importance of petroleum to a nation is not to be gauged alone by the demand for gasoline, for fuel oils, or lubricants. Importance may also be gauged by critical needs, special functions, irreplaceable services more significantly than by quantity of consumption solely. Oil is a raw material that is vital to the welfare, the industrial and military strength of nations, indeed to the very survival of nations. This paper attempts to present a brief picture of the world oil-producing districts and consuming markets, the political impediments to the free movement of oil, and some of the international tensions that have arisen as a result of the fortuitous and uneven manner in which oil resources are distributed geographically and politically.

Oil and its products are critical in national economy according to the economic and political characteristics of the nation under consideration. In the United States the dominant use is for automobile transportation, and second in quantitative importance is the use of fuel oil for commercial and domestic heating. This is also true to a large extent in Canada.

In other nations, especially those of Europe and the Far East, the character of oil demand differs from that in the United States. The use of gasoline for automobile transportation is less, proportionately, in importance. Military and industrial uses, bunker fuel, truck transportation, and marine use occupy a more important place among the powers, notably Great Britain, Germany, Italy, Japan, and Russia, where undoubtedly military and naval requirements are far greater than in the United States in proportion to total consumption.

In non-military nations such as the Scandinavian countries, oil is important in marine use for fishing vessels used in coastal fisheries, as well as in support of the larger merchant marine activities of these nations.

[1] Presented at the Illinois Mineral Industries Conference, November 16, 1940. Manuscript received, November 25, 1940. Published with the permission of the chief of the State Geological Survey.

[2] Mineral economist, Illinois State Geological Survey.

In nations ill equipped with railroads, the alternative method of bus transportation over paved roads is becoming increasingly important.

Because the products of crude petroleum are adapted and adaptable to so wide a variety of uses in industry, land and water transportation, agriculture, and in national defense, so also there are many other uses and one or more may be critical or vital to the welfare of this or that nation.

WORLD OIL PRODUCTION AND WORLD OIL PRODUCERS

Despite the wide distribution of oil production in 26 countries and on all continents except Australia, the most of the production is centered in five districts or regions. These are: (1) the North American region, (2) northern South America, (3) Russia and the Balkans, (4) the Near East, and (5) the Far East.

Each of these regions is comprised of one or more districts. In fact, districts or even states within the large North American area may exceed in output that of entire regions elsewhere. These major oil regions provide 96.5 per cent of the world's supply. The remainder is obtained from minor sources, as shown in Figure 1, and a few fields in Europe unidentified on the map.

Relation to consuming centers.—With the exception of the United States and the United Socialistic Soviet Republics, the important industrial nations of the world are lacking in petroleum resources within their own boundaries. This is graphically shown for leading countries in Figure 2. The implications of this condition are easily understood. Inadequate petroleum supplies at home or the danger of an interruption of petroleum flow from oil districts to the home industrial centers may stimulate political or military reactions of a violent nature.

In order to understand the possible international reactions to oil supply and flow, somewhat detailed recording and analysis of oil movements in international trade are essential.

We begin with an examination of the position of the United States. The United States, because of its dominant position as an oil producer, significantly affects the course of international movements of oil. True, the net export of United States oil is only about 11 per cent of the total domestic production, but this export quantity looms large when compared with the needs of important foreign nations.

For example, the net exports of crude petroleum and refined products (exports less imports) in 1938 amounted to 139 million barrels. This exceeds the consumption of every other nation with the exception of the United Socialistic Soviet Republics. What, therefore, appears to

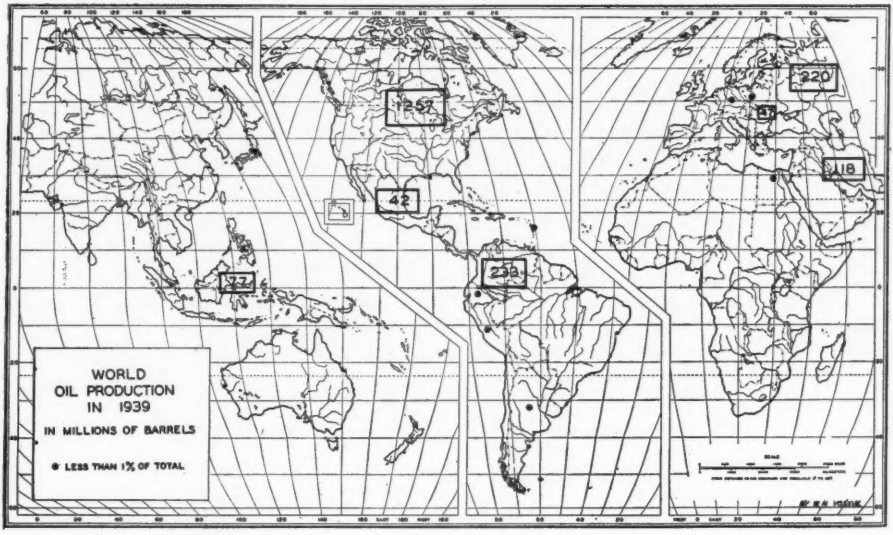
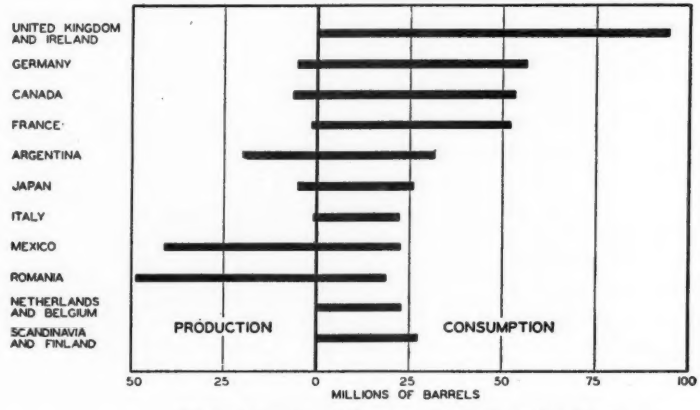


FIG. 1



PETROLEUM BALANCE IN SELECTED NATIONS, 1939

FIG. 2

be a small part of the oil business of the United States may be of vital importance to another nation.

The disparity between the oil industry in the United States and the remaining part of the world is further illustrated in Figure 3. This figure shows the number of days' supply that would be provided in the United States by a year's demand in each of six of the leading consuming nations. It also shows the number of days' demand in the United States that would be satisfied by the annual output of leading producers.

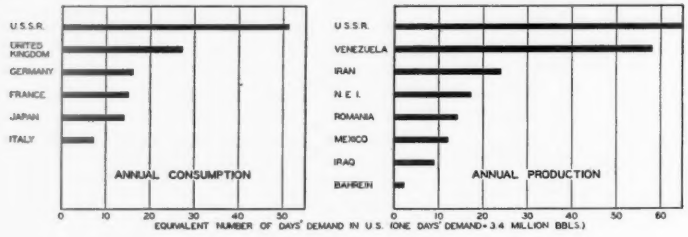


FIG. 3

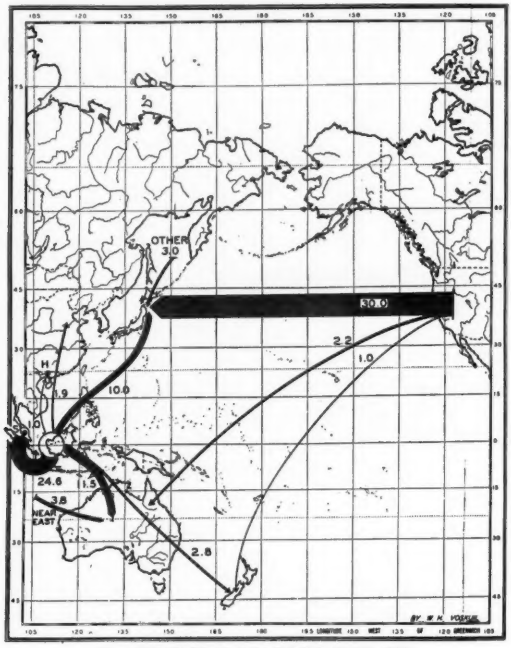
The largest export quantities of oil from the United States go eastward to the petroleum-deficient countries of western Europe, and the second largest quantity goes to petroleum-deficient Japan. The westward movement may be considered internationally more important critically than the eastward movement. Consuming nations in western Europe have access to supplies from Venezuela, Mexico, and the Near East, in addition to surplus supplies from the United States, whereas Japan and other far eastern markets must, under present conditions, rely principally on the United States.

PETROLEUM IN PACIFIC BASIN

The international flow of petroleum in the Pacific Basin is dominated by three elements: the large and growing demand by Japan; the large demand for naval purposes at the Singapore base; and the limited supply of petroleum production and reserves in the Far East area.

The consumption of oil for both military and civil purposes in 1938 in this far eastern area has been estimated at approximately 110 million barrels. This is somewhat higher than the estimates for 1939 due to a decline in Japanese demand. The principal consumers in the area are Japan, the Singapore naval base, Australia, British Malay, the Philippines, and New Zealand. Supply of oil in the immediate

locality is about 78 million barrels or an approximate 32 millions short of demand in the western Pacific area. The principal movements of oil in the Pacific Basin are shown in Figure 4.



OIL MOVEMENTS IN THE PACIFIC BASIN, 1938
IN MILLIONS OF BARRELS

FIG. 4

POSITION OF JAPAN

The largest user of oil in the Pacific area is Japan, with a recorded consumption of 25 million barrels for civil use and additional estimated consumption of 16–21 million barrels for military and naval use. To meet this demand Japan is assured only its domestic production of about 3 million barrels, including that obtained from Sakhalin, together with a limited output of synthetic fuels. With regard to the production of Sakhalin, until 1934, the greater part of the production of this island was available to the Japanese by purchase from the Russian share of the production. Although Japan owns the southern part of Sakhalin (Karafuto), exploration has shown that the most productive oil fields are in the Russian part of the island.

The oil fields of northern Sakhalin are of decisive importance to the U.S.S.R. for the petroleum supply of the Far East area, because deliveries from the remaining Russian oil fields have serious difficulties on account of the long haul involved. Since 1936 a cracking plant has been in operation at Khabarovsk, in which Sakhalin oil is refined. At present, enlargement of this refinery is under way; but it is not yet determined when the enlargement will be in operation. Hitherto for the requirements of the Far East area, large quantities of gasoline had to be imported from the United States. Recently it has been stated that in the near future the requirements of the Far East can be met completely out of its own production. In 1940 two larger cracking plants are to be built at Komsomolsk and Nikolayevsk on the Amur River. From the Russian point of view the petroleum production in northern Sakhalin is quite capable of development, after new oil formations were discovered at Ekhabi. It is anticipated therefore that petroleum from Sakhalin will become less available to Japan in the future.

Nor can the Japanese look to the Dutch East Indies for an adequate supply of petroleum short of a conquest of these islands and complete occupation. Under present conditions, the output of oil from the Straits Settlements is distributed principally to Singapore, Australia, New Zealand, and adjacent territories. An exportable surplus of approximately 10 million barrels is available, which is now being shipped to Japan.

The policy of the United States with regard to exports of petroleum and refined products to Japan becomes of critical importance to the latter. United States has in the past contributed about three-fourths of Japan's needs. The predicament of Japan in the event of an embargo on shipments from California is effectively stated by Garfias:[3]

> It might be reasonable to assume that in case the embargo goes into effect, any deficiency in Japan's supply that could not be made up from the East Indies fields could be procured elsewhere. A careful study of the actual situation, however, presents quite a different picture; to illustrate, Peruvian oil controlled by American interests would be unavailable. Petroleum from Mexico, Venezuela, Colombia, and Trinidad would have to be transported through the Panama Canal. Incidentally, the distance from these fields to Yokohama is close to 9,000 miles, or twice the distance from Yokohama to San Francisco. Petroleum from Iraq will have to be transported through the Suez Canal and by Singapore, which could only be possible if Great Britain does not coöperate with the American embargo. In view of the recent attacks of Japan against British interests in China, it is hardly to be expected that Great Britain would take the side of Japan against the United States in case

[3] V. R. Garfias, "Embargo on Petroleum Would Seriously Cripple Japan," *Oil and Gas Jour.* (August 31, 1938), pp. 26, 98.

of an embargo. For the same reason it is very doubtful that Japan could obtain its needed petroleum supply from the Persian fields controlled by Great Britain, or from those in Bahrein Island which are controlled by American interests.

In this connection, the great importance of the Singapore base in the Japanese problem of oil supply should be noted. Singapore, the eastern Gibraltar, is considered the most perfect fortress in existence, where, among other facilities, the British Government has a storage capacity for 7,000,000 barrels of petroleum products, which can easily be replenished from the neighboring East Indies fields. British Malay, in which Singapore is located, is the richest British possession or sphere of interest, exporting, among other products, about 1,000 tons of iron ore to Japan. Northwestern Borneo and the Sarawak and Brunei possessions not only produce petroleum, but on account of their location with respect to Singapore would be of assistance in guarding the approach of the East Indies from Japan to the north. With the Singapore base and its Asiatic fleet, Great Britain could make it necessary for Japan to transport any oil it might obtain from Persia, Iraq, Bahrein Island, and Arabia, a practically prohibitive distance.

It follows, therefore, that practically the only solution to this problem is for Japan to monopolize the entire output of the East Indies fields, which could be done only by depriving the region of its domestic petroleum supply. To carry out such a program, the conquest of the East Indies, the capture of the Singapore base and the British Asiatic fleet apparently becomes necessary.

OIL MOVEMENTS IN EUROPE

The European area is here defined to include the Near East in Asia and North Africa. A condition of unusually unstable industrial equilibrium exists in this area. Here is an area, somewhat smaller than the United States, if the U.S.S.R. is excluded, occupied by 350 million people of a high quality of skill and training. There is also in this area a supply of basic industrial raw materials adequate for a high degree of productivity with a potential prosperity far above the present level.

There are adequate supplies of coal in Germany, Poland, and Great Britain, of iron in France, Sweden, Great Britain, and Spain, of lead and zinc in Silesia, of oil supplies in the Near East under European control, of bauxite for aluminium in France, Hungary, and Dalmatia, of fertilizer minerals, both potash in Germany and phosphate in North Africa. All these together provide the basic materials for a high order of industrial and agricultural activity.

Imposed upon this physical unit of Europe is a political system of many small states, not one of which is supplied with all the requisite basic materials of industry. We need simply to call attention to the abundant iron reserves in a coal-less Sweden or a coal-poor Germany, or the lack of an adequate supply of all basic minerals in Italy to make clear the meaning of this.

The small-state system accompanied by tariffs, export and import quotas, limitations on the movements of population, and other hampering restrictions vitiated the efforts of management to make the most effective use of the tremendous productive power of modern power technology. What has been accomplished in the large free-trade area of the United States, with its large population of high purchasing power, similarity of languages, of taste, and desires, and a machine technology that is unsurpassed elsewhere, in the form of high productivity, has so far failed in Europe although the opportunities are comparable. The efforts to produce substitute or "ersatz" materials from high-cost materials have signally failed.

The present struggle is, among other things, a clash between extreme nationalism and modern technology. The outcome is in doubt regardless of which group of political powers achieves a victory.

Within this struggle, the position of oil is particularly vital.

NEAR EAST-MEDITERRANEAN AREA

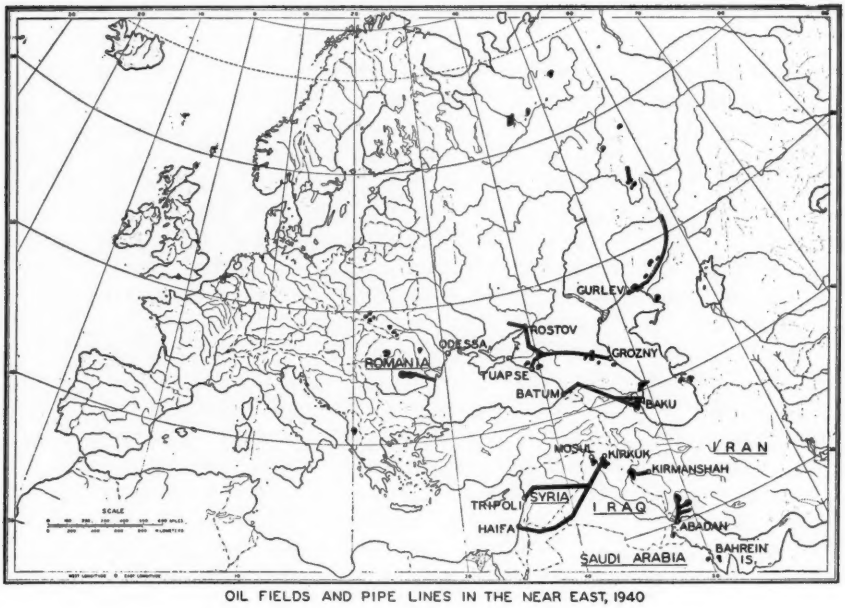
The Near East-Mediterranean area is here defined to include the oil-producing districts of Romania, Iraq, Iran, Bahrein, and Saudi Arabia. Oil fields of the U.S.S.R. are considered separately in view of the fact that nearly all of the Russian output is used within the U.S.S.R. This area is truly one of the great oil fields of the world. It is a prize which is eagerly sought by more than one European nation and may at any time be the occasion for a major military operation (Fig. 5.)

The reserves of this area are tentatively estimated at approximately 7,000,000 barrels, exclusive of Saudi Arabia and Bahrein Island, for which estimates are not available.[4] This is approximately on the same scale as Texas reserves and ranks these among the leading fields of the world. With the exception of the Romanian fields, output is increasing. The rate of growth and relative importance in output is graphically shown in Figure 6.

These fields supply almost exclusively the European nations. For some of these, the Near East oil fields are the sole source of supply.

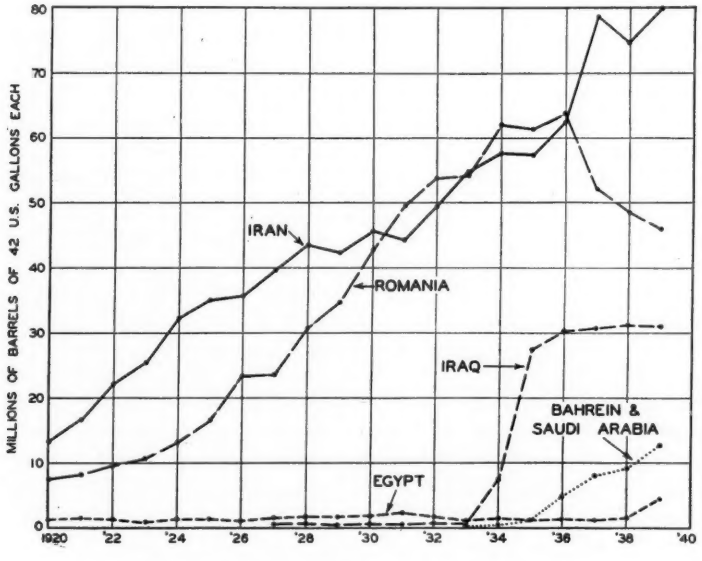
The fact of central significance with respect to the Near East oil fields is the deficiency of petroleum resources in the industrial nations of western Europe. The nations of western Europe produce only 7.5 million barrels annually which is approximately 4 per cent of the needs of Great Britain, Germany, France, and Italy under conditions prevailing in 1938 and 1939. The Near East fields take on an added inter-

[4] V. R. Garfias and R. V. Whetsel, "Estimate of World Oil Reserves," *Trans. Amer. Inst. Min. Met. Eng.*, Vol. 132 (1939), p. 609.



OIL FIELDS AND PIPE LINES IN THE NEAR EAST, 1940

FIG. 5



PETROLEUM PRODUCTION IN THE NEAR EAST

FIG. 6

national significance when viewed against the background of a politically divided Europe, comprised of powerful industrial nations seeking control of and domination over needed raw-material supplies—including petroleum. Germany in particular is vulnerable with respect to its petroleum supply. Blocked from the resources of the western world by the British navy during war, Germany is practically restricted to the limited and declining supplies from Romania together with a meager supply from Poland and such oil as Russia is willing to ship. The Near East oil fields may become one of the important battlegrounds of the world.

The current international struggle in Europe has focused attention on the Romanian oil fields largely because of their strategic position and accessibility to the axis powers. Since oil products play a vital rôle in air, naval and land warfare, the battle to secure adequate oil supplies and at the same time prevent the enemy from obtaining such supplies is part of the strategy of the present war. In this respect the Romanian oil industry has been particularly subject to pressure from contenders on both sides of the struggle. Nevertheless, the fields of Persia, Arabia, and Iraq are playing just as important, although not so noticeable, a part in the struggle for the control of the Near East.

Evaluation of Near East fields.—Five major producing districts, exclusive of Russia, comprise the oil fields of the Near East. They are: Iran, Iraq, Saudi Arabia, Egypt, and Bahrein Island. Together they produce about 125 million barrels which, if the area is considered as a unit, places this area third in rank in the world, exclusive of the United States, and comparable with Russia and Venezuela as a producer.

The leading producing nation, Iran, entered the oil industry in 1913 with production steadily rising and new discoveries continually augmenting the reserves. The Iraq district entered the picture in 1927 with an initial production of 67,000 barrels, and rose rapidly to 32 million yearly. Bahrein Island in the Persian Gulf, and Saudi Arabia on the mainland, are newcomers in the oil industry. Reserves in Iran and Iraq have been estimated at 3,500 million and 2,500 million barrels respectively. Since the discovery and rapid rise of Bahrein Island among oil producers in 1933, the attention of oil companies has been drawn to eastern Arabia, particularly to that section bordering the Persian Gulf. Exploration and development on Damman dome on the mainland opposite Bahrein Island, and in Kuwait, south of the Iraq border, seem to justify expectations that this region will some day become one of the world's important oil-producing districts.

DISTRIBUTION OF NEAR EAST OIL

Oil from the Near East fields is distributed almost exclusively to European nations. Only a small quantity is shipped to British interests in the Far East to supplement oil supply of the Netherlands East Indies. Routes of transportation are mainly over water as follows.

For Russian and Rumanian oil
Black Sea-Mediterranean route
Black Sea-Danubian route
Rail route from Romania to Germany *via* Lwow

For Iraq oil
Mediterranean route *via* pipe-line terminals at Haifa and Tripoli

For Iran, Bahrein Island, and Saudi Arabian oil
Persian Gulf-Red Sea-Suez Canal-Mediterranean route

In this transportation system, the Mediterranean is the principal highway.

Oel und Kohle comments as follows.

Although none of the countries which border on the Mediterranean Sea has any considerable domestic production of petroleum, yet the Mediterranean Sea possesses in relation to the petroleum industry an extraordinarily great importance which deserves keen interest under the existing war situation. In the first place it is a question of access to the Black Sea, which indeed is possible only by way of the Mediterranean. This plays an important rôle in the present plans for extending the war. The Black Sea is the passageway for considerable quantities of Russian oil from the Caucasus and the Romanian oil from the margin of the Carpathian Mountains. A constriction of this traffic by a penetrating naval power can create perceptible disturbances, even in the intra-Russian exchange of petroleum which runs from the terminals of the Caucasian pipe lines at Batum and Tuapse to the South Russian harbors and thence in part inland by the great rivers.

The same route is also to be taken for Russian deliveries to central and western Europe, so far as they do not prefer the longer, but for many purposes cheaper way by sea through the Straits of Gibraltar. Romanian oil is also transported over the Black Sea, namely, to Turkish and Bulgarian harbors; and more than three-fourths of the total Romanian exports are directed over the Black Sea. At any rate, so long as the peace of the Black Sea remains undisturbed, almost the entire export of Russian and Romanian oil reaches its destinations by way of the Black Sea and of the straits of the Mediterranean Sea. In the Dardanelles, laden tankers traveling westward and returning eastward in ballast are a daily, often an hourly, phenomenon.

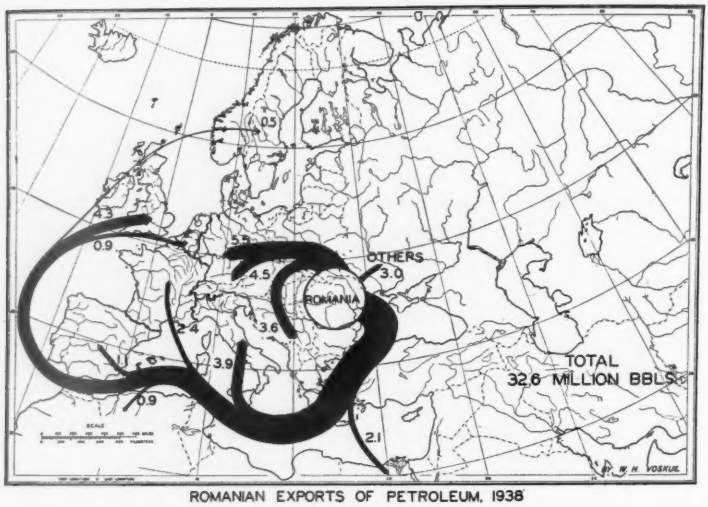
The second means of access to the Mediterranean Sea is the Suez Canal. Here pass tankers, laden principally with oil from Iran (Persia), and to a smaller extent with oil from the Red Sea fields of Egypt and from Bahrein, as well as from the Netherlands East Indies, and British Borneo, destined to southern and western Europe and northern Africa.

Finally, since 1934, the Mediterranean Sea has been connected by the terminals of the pipe lines of the Iraq Petroleum Company on British and French mandated territory (Haifa and Tripoli) to one of the great districts of the world oil industry, and has to take and distribute the entire production of Iraq (about 32.6 million barrels in 1938).

Under these circumstances naval control of the Mediterranean Sea, so far as such control can be exercised in general as a unit, possesses in part a vital significance for the oil supply of a number of countries. That is true not only of the countries bordering the Mediterranean but also of a number of countries, lying beyond the Straits of Gibraltar, which receive a part of their petroleum imports by way of the Mediterranean.

OIL MOVEMENT IN 1938

The graphs on oil flow portray the distribution of oil in the year 1938.

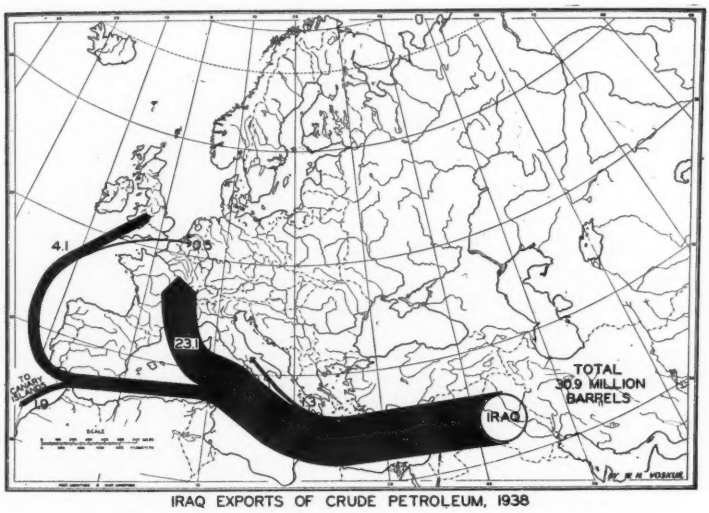


ROMANIAN EXPORTS OF PETROLEUM, 1938

FIG. 7

In a Europe divided by conflict, the oil fields and routes of transportation offer many vulnerable points open to attack. British control of the Atlantic ocean gradually reduced shipments from the Americas to Central Europe. Oil movements through the Mediterranean destined to Great Britain are subject to attack by Italy and movements through the Bosphorus are subject to the will of the Turkish Government in control of the Straits, and the British fleet in the Mediterranean. Refineries on Bahrein Island have been bombed by the Italian air force and refineries at Abadan, and oil terminals at Haifa and Tripoli are likewise vulnerable. The drastic effects of the war and naval blockade can be appreciated by comparing present restrictions with the normal flow in 1938.

The distribution of petroleum from Romanian and the Near East oil fields to consuming nations is portrayed in Figures 7, 8, and 9. The relationship of the fields in Iraq and Iran to consuming nations is of particular interest. Oil from the Iraq fields (Fig. 8) moves by pipe line to terminals at Tripoli in Syria and Haifa in Palestine. Although the oil fields are owned by both British and French interests, the bulk of the oil moves to France as crude for refining. A refinery is in process of construction at Haifa.



IRAQ EXPORTS OF CRUDE PETROLEUM, 1938

FIG. 8

Oil from the Iran fields (Fig. 9) is largely refined before shipment. In addition to the normal movement to the British Isles, the products of these refineries supply also the British naval and air forces in the Near East.

PROBLEMS OF MAJOR EUROPEAN POWERS

The entry of Italy into the European war disrupted the normal flow of petroleum and its products, necessitating the establishment of new lines of flow. Shipments through and into the Mediterranean were sharply curtailed or stopped altogether. Oil from Iran destined for England was redirected to the Cape of Good Hope route. Each of the participants in the European struggle was confronted with a problem of oil supply.

Great Britain.—Aside from the necessity of maintaining connections with oil supplies in both the Netherlands West Indies and the Near East oil fields, Great Britain must safeguard the supply of naval fuel and aviation gasoline for the operations in Egypt and the eastern Mediterranean. The main sources of refined fuels are the refineries at Abadan and on Bahrein Island with capacities of 280,000 and

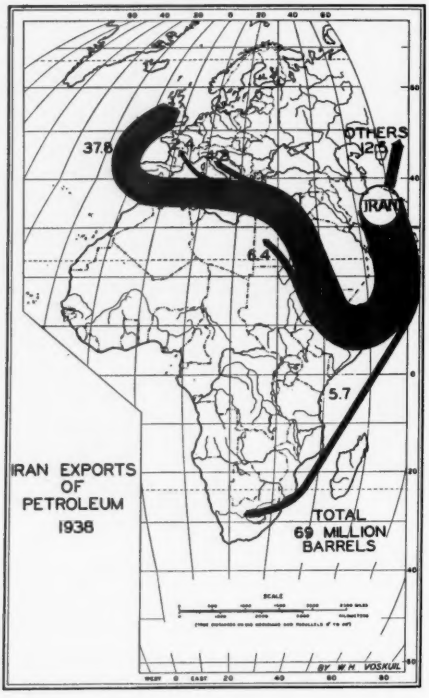
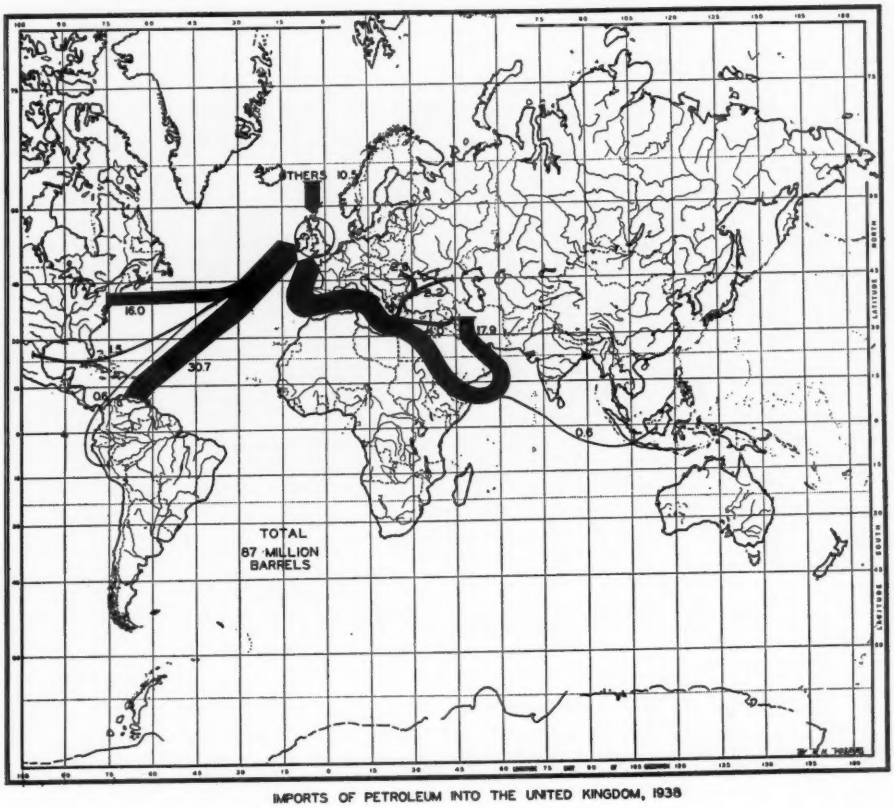


FIG. 9

32,500 barrels daily, respectively. A 40,000-barrel refinery in Haifa at the British terminal of the pipe line from the fields in Iraq adds to the eastern Mediterranean supply.

In the Pacific area, the principal concern of Great Britain is to safeguard the supply of oil for the Singapore naval base. This oil is obtained almost exclusively from the Netherlands East Indies and Sarawak (Fig. 4).

Problem of Germany.—Although Germany has a small petroleum industry approximating 4 million barrels a year, the main dependence



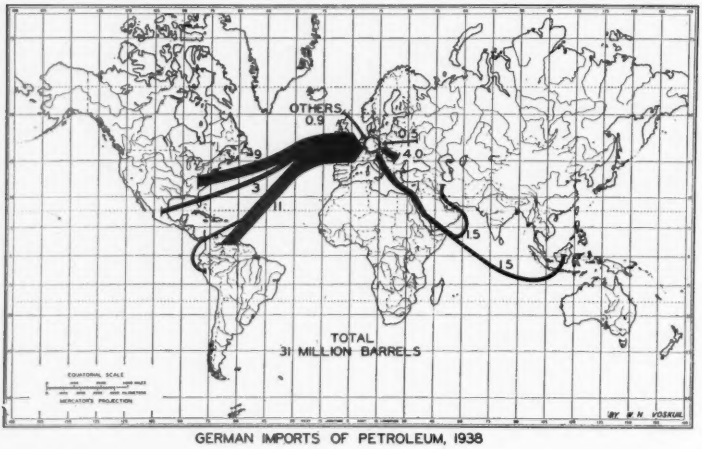
IMPORTS OF PETROLEUM INTO THE UNITED KINGDOM, 1938

FIG. 10

of this section is on imports and on hydrogenated and synthetic liquid fuels. The German picture in 1938 was as follows.

	1,000 Barrels
Imports of crude and refined oils	31,300
Synthetic motor fuels	18,900
Domestic production	4,400
Total	54,600

The source of petroleum and its products in that year is shown in Figure 11. With the exception of small shipments from Russia, Ru-



GERMAN IMPORTS OF PETROLEUM, 1938

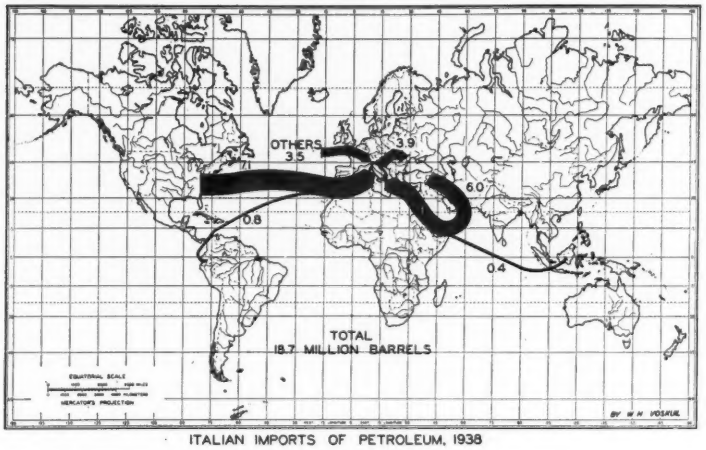
FIG. 11

mania, Iran, and the Far East, the German nation placed its dependence for oil on the western world.

With the outbreak of hostilities, certain sources of oil were closed to Germany or at least sharply curtailed. It is reported that petroleum from the Americas continued to flow into Germany through Italy, Spain, and the Low Countries, for several months during the course of the war. The conquest of the Low Countries and France and the entry of Italy into the war enabled the British to establish a more effective blockade in the Atlantic and through the Red Sea route so that, at the present time, Germany is limited to the resources of Romania together with the meager European production and to whatever supplies she is able to obtain from U.S.S.R. The problem for

Germany, however, is more than merely shifting from one source to another. The gross output of Romania may appear to be sufficient for Germany's needs, if all other sources of supply are cut off, but may nevertheless be insufficient in two respects: (1) the refined products of Romanian crude may not coincide with German needs; (2) the population of conquered nations must be maintained and, for this maintenance, a certain amount of petroleum to operate fishing vessels and transportation is necessary.

The problems of Italy with respect to oil are practically identical with those of Germany (Fig. 12).



ITALIAN IMPORTS OF PETROLEUM, 1938

FIG. 12

Position of U.S.S.R.—As the largest producer of oil in the European area, the position of the U.S.S.R. must be considered. Although the U.S.S.R. claims large reserves and claims that oil is being produced in several districts, the Baku district is still the backbone of the oil industry, with 60–70 per cent of the total production. The U.S.S.R. is at present not an important factor in the international oil trade of the Near East. Exports of crude petroleum and refined products have fallen from a high level of 30 per cent of production in 1932 to 4 per cent of production in 1938. Meanwhile production has risen each year. The program of industrial development, military expansion, and mechanization of agriculture has tended to absorb most of the oil output of the U.S.S.R.

RUSSIAN PRODUCTION OF CRUDE PETROLEUM*

Year	*1,000 Barrels*	*Exports*
1929	100,000	28,742
1930	127,000	35,970
1931	166,000	39,693
1932	157,000	45,897
1933	157,000	36,241
1934	178,000	31,925
1935	185,000	24,483
1936	202,000	19,340
1937	199,000	14,604
[a]1938	206,000	7,922
[b]1939	217,000	

* Roush, *Mineral Industry during 1939*, Vol. 48, p. 448.
[a] Preliminary.
[b] Estimated by *Oil Weekly*.

RELATION OF WESTERN WORLD TO OIL TRADE

Venezuela, through the refineries in the Netherlands West Indies, is, in normal times, an important contributor to the oil supplies of Europe. Of a total export of 130 million barrels in 1938, Europe took 44 million barrels of gasoline and fuel oil. The principal takers were the United Kingdom, Germany, the Netherlands, and Italy. Production in Venezuela so far exceeds consumption in the South American area that a surplus is available for export. Shipments to the United States are limited mainly to consumption by seaboard refineries as to imports in bond.

The position of the United States in the oil trade of the world has been stated at the beginning of the paper. These two surplus areas can provide western Europe with all its oil needs.

ACKNOWLEDGMENTS

Data from which the figures were constructed and tables prepared were obtained from *International Petroleum Trade* of the United States Bureau of Mines; the *Transactions* (1939–1940) of the American Institute of Mining and Metallurgical Engineers; and the *Oil and Gas Journal*.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 25, NO. 3 (MARCH, 1941), PP. 371-415, 6 FIGS.

UPPER PALEOZOIC OF WESTERN AUSTRALIA: CORRELATION AND PALEOGEOGRAPHY[1]

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ABSTRACT

The paper reviews the upper Paleozoic rocks in the three most important districts of Western Australia: Irwin River, North-West Division, and West Kimberley Division. The strata and their fossils are described in broad outline and a correlation between the three sequences is suggested. Glacial deposits are found at the base of the sections followed by a variety of marine and lacustrine, or estuarine, sediments of considerable thickness. The Western Australian strata are compared with those of eastern Australia, particularly of New South Wales, and it is indicated that the general succession, lower Marine—lower Coal Measures—upper Marine, which is characteristic of the Hunter River area in New South Wales, can also be recognized in Western Australia. It is concluded that glaciation in Western Australia began about at the beginning of Sakmarian time and that sedimentation continued until the early Kungurian. Correlations with Russia, India, and Timor are made. The Permian glaciation of Australia was a single major event with the strongest refrigeration during the Sakmarian and much less severe conditions, with one major interglacial period, during the Artinskian. Rich marine faunas arrived in Australia after the climax of the glaciation had been passed. The upper Paleozoic strata of Western Australia were deposited in a geosynclinal trough which was marginal to the pre-Cambrian shield and continuous with the Timor geosyncline of the East Indies. The relative geographical position of Australia and the East Indies in late Paleozoic time must have been very much the same as at present.

INTRODUCTION

This paper deals with those rocks in Western Australia which here—as elsewhere in this continent—were until recently classified as "Permo-Carboniferous." There has been a growing tendency in recent years to include these rocks unrestrictedly in the Permian. Whether or not or to what extent this seems justifiable is discussed in a later section of this paper and until then the writer refers to these strata as "upper" or "late Paleozoic."

Strata of this age are developed in three important districts of Western Australia (Fig. 2): (1) Irwin River district, (2) North-West artesian basin, (3) an area of unknown extent in the northern part of the state of which that part which belongs to the Kimberley physiographic division has been investigated in some detail. In addition, the Collie coal basin in the southwestern part of Western Australia is of

[1] This is the thoroughly revised and much altered manuscript of a paper read in January, 1939, at the Canberra meeting of Section C (Geology) of the Australian and New Zealand Association for the Advancement of Science of which a short abstract has been printed in the Reports of that meeting (Teichert, 1939b). Subsequent field work, during 1939 and 1940, has necessitated certain alterations. Although field work and study of the faunas are continuing, it is thought that the substantial increase in knowledge of this matter during the past 5 or 6 years not only justifies, but makes desirable, an attempt to summarize the pertinent facts and their bearing on general questions. Manuscript received, September 4, 1940.

[2] University of Western Australia.

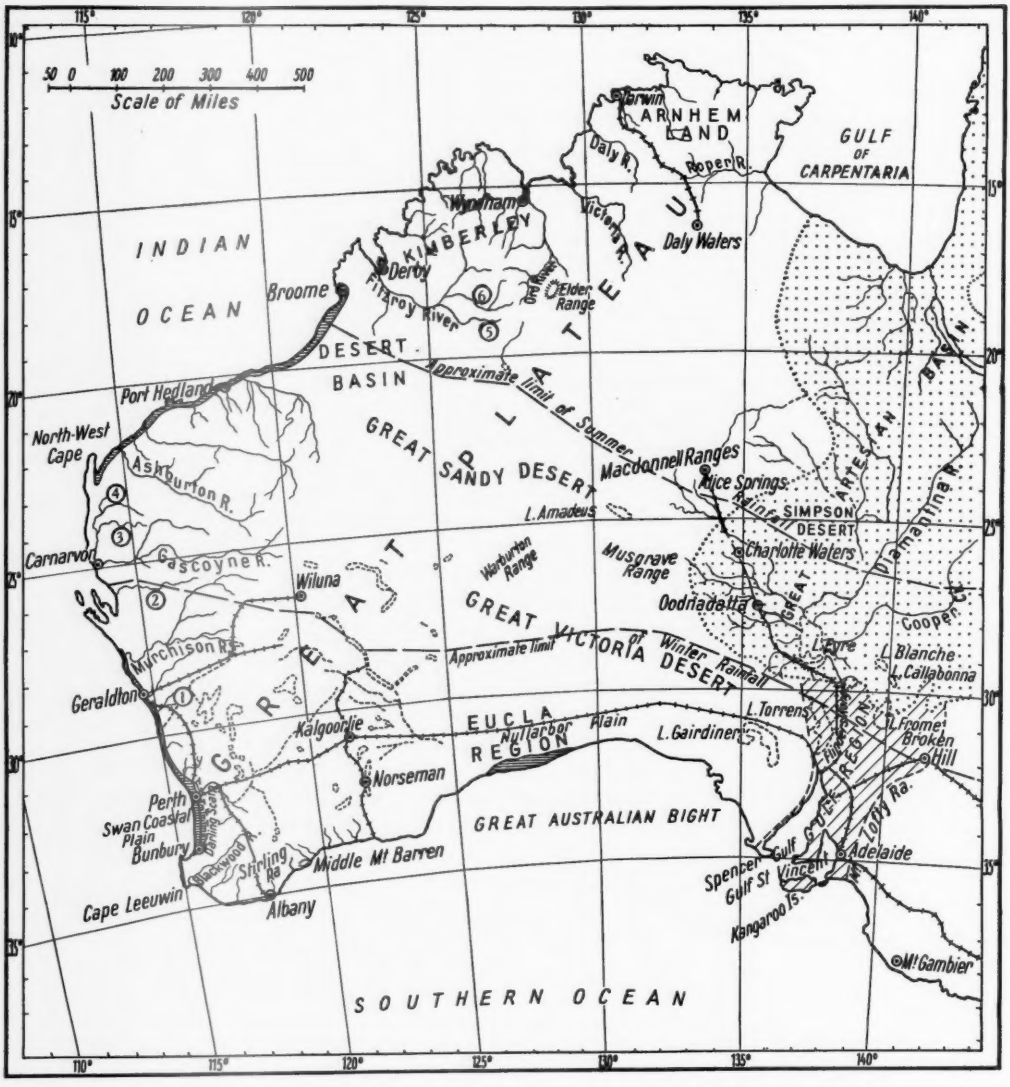

FIG. 1.—Physiographic map of middle and west Australia (adapted from E. de C. Clarke, 1938). Rivers are indicated by numbers: (1) Irwin River, (2) Wooramel River, (3) Minilya River, (4) Lyndon River, (5) Christmas Creek, (6) Margaret River.

the same general age, but as no recent information on this small area is available and its exact correlations have not been established it will not be considered in detail in this paper.

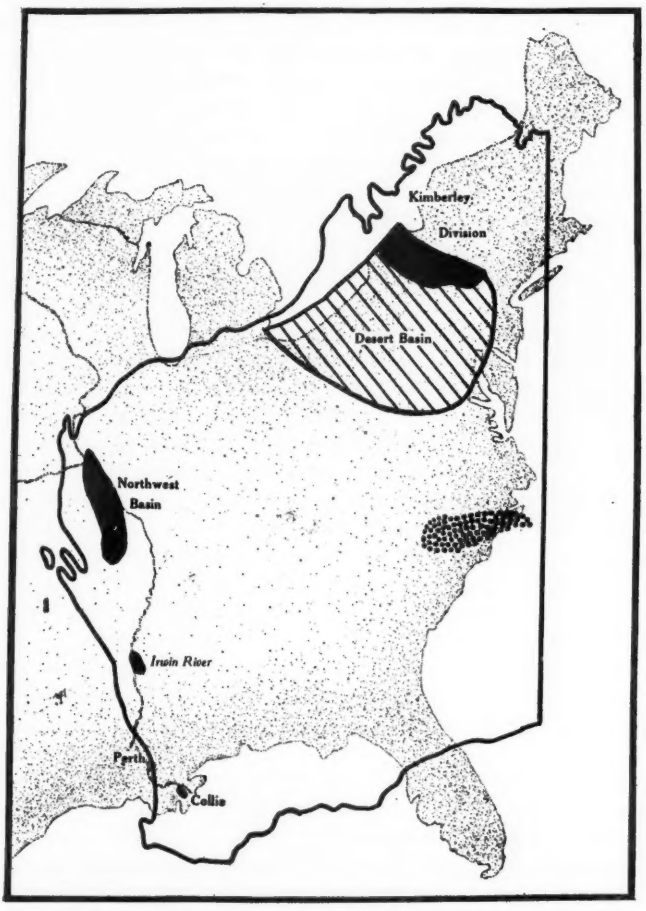

FIG. 2.—Sketch map of Western Australia, showing distribution of outcrops of upper Paleozoic rocks in black. Diagonal lining indicates area of practically unknown stratigraphy. Stippling shows approximate distribution of boulder beds of Warburton Range of questionable age. Outlines of eastern United States and Mississippi River are shaded for comparison in same scale.

The first mention of the occurrence of late Paleozoic strata in Western Australia was apparently made by Sir George Grey as early as

1841 (Maitland, 1919). Fossils of "Carboniferous" age were, however, first mentioned from the Irwin River in an appendix to a paper by E. Gregory in 1861, but R. Etheridge must have had so little confidence in these reports that he did not include any Paleozoic species from Western Australia in his *Catalogue of Australian Fossils* which was published in 1878. The first detailed description of a few species from the Gascoyne River area seems to have been given by Hudleston in 1883 and in 1884 Hardman reported the presence of "Carboniferous" fossils in the West Kimberley district. More fossils, partly from Hardman's collections, were described in 1890 by Nicholson, Hinde, and by Foord and since then papers dealing with Western Australian late Paleozoic faunas have appeared at intervals. Notable among the contributors were R. Etheridge, Jr., in the earlier part of this century, and L. F. Hosking, K. L. Prendergast, and D. Hill in more recent years. References to these and other papers are made where necessary in the following paragraphs.

For field relations it is (for the present purpose) sufficient to refer to the most recent sources. The geology of the Irwin River district was last described in a paper by Woolnough and Somerville in 1924. Since then much unpublished information has been accumulated by Professor E. de C. Clarke and students (unpublished manuscript by Prendergast and Luck), and some of this, by kind permission, has been incorporated in this paper. The geology and stratigraphy of the North-West district are described in papers by Condit, Raggatt, and Rudd (1936), by Raggatt (1936), and by Raggatt and Fletcher (1937), and on the Kimberley Division recent reports by A. Wade (1936, 1938) are available.

Since 1938 the writer has spent at various times about 25 weeks in the field investigating upper Paleozoic strata in all three districts, but few results have yet been published. Also, in 1939, he had the opportunity of studying important "Permo-Carboniferous" sections in eastern Australia, particularly in New South Wales, and the following correlations of eastern and western sequences are, therefore, based on some amount of personal experience.

It is a pleasant duty to render sincere thanks for, and appreciation of, the assistance the writer has received in the prosecution of this work. Travelling grants were made available from the Commonwealth Grant to the University of Western Australia under the research program of the Council for Scientific and Industrial Research. Travelling facilities in the Kimberleys were provided by the Freney Oil Company, Ltd., Perth, and in New South Wales by the Geological Survey of New South Wales, and by the Department of Geology of

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In considering the relative value of the results of all this work a few facts should be remembered: Western Australia equals in size approximately all of the United States east of the Mississippi River (compare Fig. 2). The great majority of the population of scarcely half a million is concentrated in the extreme southwest. Poor roads and lack of railway lines make field work more costly and difficult with increasing distance from the populated area and Perth, its administrative and research center. Nearest among the areas described in this paper is the Irwin River, 260 miles from Perth; farthest the Kimberley district, 1,300 miles from Perth in a northerly direction along the coast, with Paleozoic strata extending another 300 miles inland from the coast. The population is extremely sparse and in the north large parts of the country have not been taken up by white men. It is, therefore, evident that the geological data are of very unequal value. Detailed investigations have been carried out in a few places, large parts are covered by broad reconnaissance work, and there are still wide stretches from which only occasional or no observations are available.

From an economic point of view the stratigraphy of the areas here under consideration has received and is still receiving the attention of

various oil companies which have instigated geological explorations in the North-West and Kimberley districts and a great number of the data on which the conclusions in this paper are based have been accumulated by geologists engaged in this practical work. Renewed drilling operations are at present in progress to test the oil possibilities of certain structures in the Fitzroy River Basin (Kimberley district). Furthermore, upper Paleozoic strata are prominent in the two largest artesian basins in Western Australia, namely, the North-West and Desert basins; full knowledge of these strata is, therefore, necessary, before it will be possible to utilize the water resources of these basins in the most satisfactory and economic way.

For the convenience of the reader a physiographic map of middle and west Australia is here reproduced as Figure 1 in which most of the geographical names used in this article may be found.

SUMMARY OF STRATIGRAPHY

The following summary of stratigraphy is very incomplete in its references to fossil faunas for knowledge of them is in deplorable contrast to the large amount of material which has already been collected. Probably not more than 20 per cent of the total number of species have been described and many of the earlier names are in need of revision. Too often names of eastern Australian or Indian species have been attached to Western Australian forms and care should be exercised in the perusal of such references. Preliminary determinations are of little use in correlation and no fossil name is, therefore, used in the following unless the writer feels reasonably satisfied that its application is correct.

IRWIN RIVER DISTRICT

Good exposures are found 30–40 miles from the coast of the Indian Ocean. Here, two branches, known as North Irwin and South Irwin, unite to form the main river, and here as well as farther downstream and toward the south the complete upper Paleozoic sequence is exposed.

The sequence is now known to be as follows.

	Feet
White sandstone and shales	200?
"Upper Marine series." Carbonaceous shales with ferruginous sandstone layers and erratic boulders	120
Coal Measures. Laminated and cross-bedded, plant-bearing sandstones with several coal seams	140
Fossil Cliff limestone. Fossiliferous shale with limestone layers and lenses	190
Metalegoceras series. Mostly unfossiliferous shales with limestone and claystone	2,500
Tillites, calcareous grits, and Fontainebleau sandstones	200
Total	3,350+

The strata are folded in a long broad anticline with dips as great as 20°. The axis of the anticline trends approximately northwest and southeast with a northwesterly pitch. A noticeable feature of this succession is the comparatively small thickness of glacial beds at the base. A number of very large boulders of pre-Cambrian rocks are situated almost in a straight line near the axis of the anticline and it is suggested by E. de C. Clarke that this may indicate that the pre-Cambrian basement here is not far below the surface. If that is so, the small thickness of the Irwin River glacials would be real and not due to insufficient exposures.

The *Metalegoceras* series is essentially unfossiliferous. It covers rather large areas on both sides of the anticline which, owing to the axial pitch, closes toward the northwest. The only important fossil is *Metalegoceras jacksoni* which on the northeast limb of the anticline occurs in a series of three parallel linear outcrops. On the southwest limb only one continuous line of outcrops with *Metalegoceras* has been found. Although the field evidence is inconclusive it seems nevertheless most likely that *Metalegoceras jacksoni* in places occurs at three different levels between 800 and 1,500 feet above the glacial beds.

Species characteristic of the Fossil Cliff limestone begin to appear in the upper shales of the *Metalegoceras* stage (*Linoproductus cora* var. *foordi* Etheridge, *Warthia* and other small gastropods) and a natural boundary between these two series of strata has not yet been worked out. It seems, however, that throughout a thickness of several hundred feet above the uppermost *Metalegoceras* band the shales are unfossiliferous or almost unfossiliferous. The Fossil Cliff stage at the top of this series is still predominantly shaly, but abundantly fossiliferous limestone lenses are intercalated. The fauna consists of more than one hundred species among which brachiopods are the most abundant in number of species and individuals (*Linoproductus, Taeniothaerus, Chonetes, Strophalosia, Spirifer, Syringothyris, Streptorhynchus, Cleiothyridina, Seminula,* and others). Bryozoa are another important group which is represented by fenestrellinids, *Hexagonella, Streblotrypa,* and others. The rest of the fauna is composed—in descending order of importance—of lamellibranchs (*Edmondia, Sanguinolites, Stutchburia, Deltopecten, Aviculopecten, Conocardium, Allorisma*), gastropods (*Bellerophon, Warthia,* pleurotomarids, *Conularia*), non-fusulinid Foraminifera, corals (*Pterophyllum, Euryphyllum, Gerthia*), nautiloids (*Pseudorthoceras, Domatoceras, Stearoceras*), crinoids, ostracods, and trilobites. The fauna of the contemporaneous shale facies is very much impoverished and consists almost exclusively of productids and fenestrellinids.

The Coal Measure series lies conformably on top of this marine shale and limestone series and begins with massive cross-bedded sandstone. Finer, partly laminated, sandstones and shales interbedded with one to four coal seams are characteristic of the higher part of this series. Several plant horizons have been found in this sequence. The general succession of these is as follows (in descending order).

Bothrodendron beds
Sphenophyllum beds
Glossopteris beds
Sphenopteris beds
Glossopteris beds

Most prolific is the flora of the *Sphenopteris* beds which contain (according to preliminary determinations mainly by Miss V. Sims) *Sphenopteris lobifolia, Glossopteris browniana, Glossopteris indica, Glossopteris angustifolia, Gangamopteris* sp., *Sphenophyllum* sp., *Cladophlebis roylei, Phyllotheca australia.* Numerous species are also represented in some of the other beds and of special interest is the occurrence of *Bothrodendron.*

The next following series of carbonaceous shales and ferruginous sandstone is almost unfossiliferous. David and Sussmilch (1936, p. 637) report the occurrence of *Aviculopecten* in these strata and in 1939 an indeterminable fragment of a lamellibranch was found which, however, was unlike an *Aviculopecten.* Furthermore, in one sandstone horizon invertebrate trails are numerous. Some of these resemble trails which are very abundant in the Byro and Wandagee series of the North-West. Erratic boulders of granite and gneiss occur in at least two horizons. Their presence can hardly be explained otherwise than by assuming ice-borne transport. The marine nature of this series—already indicated by David and Sussmilch and by Condit, Raggatt, and Rudd (1936)—is beyond doubt and in the following these strata will be referred to as the "Irwin River Upper Marine."

The sequence at the Irwin River closes with a series of whitish and gray fine-grained sandstones and shales in which no fossils have yet been found and the thickness of which has not yet been determined. It should, however, be not less than 200 feet thick and is probably more.

NORTH-WEST DIVISION

The upper Paleozoic rocks occur here in an area which is known as the North-West artesian basin. The structure of this "basin" is much more complicated than was assumed only a few years ago. Field work mainly by Raggatt, Rudd, Waterford, and the writer has shown that considerable faulting is evident and that folding has taken place which resulted in the formation of anticlinal and dome structures. Artesian

conditions are, therefore, not present everywhere. The entire area is made up of strata of upper Paleozoic, Cretaceous, and Tertiary age. Jurassic is known from only one isolated occurrence on the Minilya River. The Cretaceous is well developed from the Aptian at least to the Maestrichtian and all the main divisions of the Tertiary are represented.

The upper Paleozoic strata are exposed along a belt up to 60 or 70 miles wide, extending from about 20 miles south of the Wooramel River in the south to somewhat north of the Lyndon River in the north, or, roughly speaking, between 23° and 26° South latitude. The information regarding this area is derived from sources of unequal value. Most parts have been the subject of reconnaissance work only and detailed investigations are limited to restricted areas. As far as is known at present, lateral changes in facies and thickness of the strata exist in certain parts of the section but these conditions are as yet poorly understood.

Raggatt's standard section (1936) probably applies mainly to the country around the Gascoyne River and farther north along the Lyons River and the Kennedy Range. Following Raggatt, this section can be described as follows.

	Feet
Kennedy stage. Almost wholly sandstone, with *Spirifer, Strophalosia, Cardiomorpha*	700
Byro stage	
(e) Massive sandy micaceous mudstone with calcareous lenses (*Spirifer byroensis*)	
(d) Cross-bedded brown and greenish sandstone, fossiliferous	
(c) Sandy mudstones, dark shales, white sandstones	2,400+
(b) Sandy limestone, calcareous sandstone and dark shales with small glacial erratics	
(a) Carbonaceous shale	
Wooramel stage. Mainly medium-grained white sandstone. Few fossils	130– 180
Callytharra stage. Divisible into upper flaggy limestone and lower calcareous mudstone with limestone bands. Very fossiliferous	200– 460
Lyons series. Upper shaly group with thin fossiliferous limestone beds and lower sandy group with eight glacial conglomerates. Marine fossils present	2,150–2,400
Total	5,580–6,140

The Wandagee stage which forms the top of Raggatt's section above the Kennedy sandstone is here omitted for reasons which will be explained. The entire sequence above the Lyons series is termed Gascoyne series by Raggatt. Since several of the "stages" of this series will eventually have to be further subdivided, it is here proposed to raise them to the rank of "series" and to apply the term "Gascoyne system" to the entire upper Paleozoic sequence in the North-West.

Conditions appear to have been rather uniform throughout the entire North-West district during the time of the formation of the

Lyons and Callytharra series which seem to be fairly uniformly developed. According to Raggatt and Fletcher, the lower 500–800 feet of the Lyons series are unfossiliferous and the lowest fossil horizon is recorded at about 1,600 feet below the top of the series, containing fenestrellinids, crinoid remains, and *Conularia warthi* Waagen. A further fossil horizon with *Plerophyllum australe* and *Chonetes "pratti"* is recorded at 1,300 feet below the top of the series. The upper, shaly, part of the Lyons series is more abundantly fossiliferous and is characterized by a number of species of the typical Callytharra fauna, namely, *Plerophyllum australe*, *Hexagonella dendroidea*, *"Amplexus" pustulosus*, *Cleiothyridina macleayana*, *Linoproductus cora* var. *foordi*, *Dictyoclostus callytharrensis*, and others.

The Callytharra limestone is abundantly fossiliferous. Raggatt and Fletcher (1937, p. 169) list 82 species in this series. At the type locality, Callytharra Springs on the Wooramel River, a calcareous mudstone facies predominates which is fairly rich in crinoids and blastoid remains. The Timor genus *Rhopaloblastus* seems to be among the representatives of the latter group. Farther north the Callytharra series develops into flaggy, hard limestones. The fauna shows great resemblance to that of the Irwin River Fossil Cliff limestone as was first recognized by L. F. Hosking in 1932. Bryozoa and Brachiopoda are by far the most predominant groups of the Callytharra fauna and the species which it has in common with the Fossil Cliff fauna include numerous fenestrellinids, *Dictyoclostus callytharrensis*, *Cleiothyridina macleayana*, *Spirifer hardmanni*, and others. Unlike the Fossil Cliff fauna the Callytharra fauna seems to include very few lamellibranchs.

North of the Gascoyne River the Callytharra series increases in thickness and a subdivision into two or three stages seems to be feasible in the Moogooloo Range, north of the Minilya River. The series is here abundantly fossiliferous, but no detailed work has yet been attempted in this section.

The Wooramel sandstone appears as a series of great lithological uniformity over great distances in the northern part of the North-West district and southward for some distance south of the Gascoyne River. In the Wooramel River area there seems to be no clear distinction between the Wooramel sandstone and the basal sandstones of the overlying Byro series. As Raggatt has pointed out, the Wooramel sandstone is an important water-bearing formation.

As regards the sequence above the Wooramel sandstone considerable facies differences exist in different parts of the North-West. Raggatt's description of the sequence, reproduced in a preceding paragraph, seems to be fairly representative of conditions as they

prevail along the Gascoyne River and for at least 60 or 70 miles north along the Lyons River and the Kennedy Range. Still farther north, along the Minilya River, the thickness of strata corresponding with the Byro series increases considerably and the sequence here can not be compared directly with that on the Gascoyne. The total thickness of the upper Paleozoic beds must be about 8,100 feet in the Minilya River area.

The sequence above the Wooramel sandstone in the Minilya River district can be described as follows.

	Feet
Kennedy sandstone. Well bedded medium- to coarse-grained sandstones with few fossiliferous beds	200+
Wandagee series. Well bedded fine- to medium-grained sandstones with some shale in lower part and one or two limestones	2,600
*Cundlego series.** Fine-grained shaly to coarse-grained massive sandstones, commonly cross-bedded, with many intercalations of shale	1,500
*Bulgadoo series.** Carbonaceous shales with sandstone here and there	1,000?
Total	5,300

* Series names here proposed.

The general succession of facies in this sequence is similar to that in the Byro series. The shales of the Bulgadoo series correspond with the basal shales of the Byro series. They are very poor in fossils, *Chonetes* being the only form which is numerous in places. These shales which are, in places, highly gypsiferous, are known by local drillers as "Black Jack" and salt water is commonly found in them. Unfortunately, it is not realized by the drillers that "Black Jack" shales also occur between the porous sandstones of the higher part of the section and shallow water bores are usually discontinued as soon as the "Black Jack" is struck.

Sandstone becomes more predominant in the Cundlego series and fossils become more numerous. So far, only the upper half of this series has been studied in some detail. About 500 feet below the top of the series *Streptorhynchus* is very prominent at one horizon and in the upper part of the series hard, massive, cross-bedded sandstones appear. The sandstones form long, low, continuous outcrops many of which can be followed over considerable distances and which form an outstanding feature in the monotonous plains south of the Minilya River. Fossils are rare in these sandstones although pockets with a rich fauna of *Spirifer* and *Aviculopecten* are found. One more persistent fossiliferous horizon occurs about 200 feet below the top of the Cundlego series which is characterized by the first appearance in this section of the crinoid *Calceolispongia* whose many species make excellent horizon-markers in the following Wandagee series. It was these prominent massive sandstones of the upper Cundlego series that were

thought by Raggatt to be Kennedy sandstone and that led him to place the Wandagee series at the very top of the Paleozoic sequence, above the Kennedy sandstone.

The Wandagee series is extremely fossiliferous. Raggatt and Fletcher (1937, p. 170) listed 11 species from these beds, but the number of species which has now been collected from them is more than 100 and probably approaches 150. Owing to this abundance of fossils it has been found convenient to subdivide the Wandagee series into four stages. In place of a provisional division proposed in a previous paper (Teichert, 1939a) and of the division used by Higgins and Carroll in 1940, the Wandagee series is now subdivided as follows.

	Feet
Linoproductus stage. Fine- to medium-grained sandstones, in many places strongly ferruginous	1,090
Schizodus stage. Well bedded, shaly and friable sandstone of greenish gray to brown color. In places strongly fossiliferous in upper part, but in other places almost unfossiliferous	340
Calceolispongia stage. Gray, fine- to medium-grained sandstones with a few carbonaceous shales. Very highly fossiliferous	560
Lingula stage. Bituminous and gypsiferous shale predominant, with numerous sandstones and a few limestones	590

It has been possible to distinguish 32 distinct fossil horizons in these four stages. Fossils are still rare in the *Lingula* stage which contains, in places, a rich fauna of arenaceous Foraminifera such as *Hyperamminoides* and *Ammodiscus* (personal communications from W. J. Parr, of the Mines Department, Melbourne). One limestone is noticeable for its abundance of spiriferids, associated with lamellibranchs and the nautiloid *Permonautilus*. This is the lowest part of the Wandagee series which contains *Calceolispongia*.[3]

The *Calceolispongia* stage is so called, not because *Calceolispongia* is restricted to its beds, but because this genus here has its greatest development in the number of species and of individuals. Dense colonies of this peculiar crinoid existed when these beds were deposited and thousands of calicular plates are commonly found on an area of only 1,000 or so square yards. Other characteristic fossils of this stage are large productids (*Taeniothaerus*), *Spirifer rostalinus*, and many other spiriferids, *Strophalosia kimberleyensis*, *Cleiothyridina royssii*,

[3] This genus will be described in detail in a future publication. It was established in 1915 by R. Etheridge on a few isolated basal plates from strata in the Kimberley district which that author believed to be sponges (hence the name!). The genus is well represented in the Bitaoeni and Basleo beds of Timor where it was first described by Wanner in 1916 as *Dinocrinus*. Gerth, in 1936, first noted the resemblance of *Calceolispongia* to *Dinocrinus* and since complete dorsal cups of *Calceolispongia* have now been found in the Wandagee series it can no longer be doubted that these names are synonymous. The genus belongs to the family Poteriocrinidae. It occurs first in the Callytharra limestone and its many species are among the best horizon markers of the beds of the Wandagee series.

all of which occur in great quantities, in addition to many other less numerous brachiopods. Bryozoa, mainly fenestrellinids and *Geinitzella*, are fairly numerous, and several genera of crinoids in addition to *Calceolispongia* have been found. Among the gastropods are a large species of *Bellerophon*, *Warthia*, *Conularia*, and others. The coral fauna includes *Euryphyllum reidi* Hill and *Verbeekiella mersa* Hill as the two most conspicuous representatives and among the nautiloids are species of *Stearoceras* and *Titanoceras*. Lamellibranchs are represented by numerous paleopectinids and by *Cardiomorpha blatchfordi* and other genera. Among the rarer groups are the blastoids, represented by one species of the Timor genus *Pterotoblastus*, and the ammonoids, including a species of *Propinacoceras*. Many of these fossils, including *Pterotoblastus* and all the cephalopods are here recorded for the first time in Australia. The beds of the stage consist mainly of ferruginous and calcareous fine-grained sandstones and micaceous shales. Some dark shales, slightly carbonaceous, are also exposed.

These highly fossiliferous horizons of the *Calceolispongia* stage are followed by the more barren beds of the *Schizodus* stage. In the lower part this stage consists of platy to thin-bedded gray sandstones with a few fossils, mainly chonetids. These beds are followed by friable dark olive-gray sandstones which in many places contain one or more shell banks, exclusively composed of lamellibranchs among which a species of *Schizodus* is the most conspicuous. Still higher, a great variety of lamellibranchs is found, including pectinids, *Cardiomorpha*, *Stutchburia*, *Oriocrassatella*, and also *Schizodus*.

The *Linoproductus* stage includes numerous fossil horizons. In most of these a species of *Linoproductus* can be found. The lower part of this stage is particularly rich in fenestrellinids which characterize two conspicuous fossiliferous horizons at the base of this stage. These are followed by horizons with *Thamnopora immensa* whose coralla locally reach diameters of 10 centimeters, and with a large species of *Cleiothyridina*. The higher fossil horizons have not yet been worked out to full satisfaction. The fauna is varied and rich. Near the base of the stage *Helicoprion davisii* was found (Teichert, 1940a). A species of *Paragastrioceras* (s. str.) occurs at the same level, whereas a new species of *Pseudogastrioceras*, very closely related to *Pseudogastrioceras suessi*, has been found at various levels in the *Linoproductus* stage. *Propinacoceras* also occurs in the lower part of the stage. Among the crinoids a giant species of *Calceolispongia* is found. Among the Bryozoa of the higher horizons is *Dybowskiella* and among the brachiopods are species of *Waagenoconcha* and a small *Dictyoclostus*. The nautiloids include *Phacoceras*. There are lenticular occurrences of a

rich lamellibranch fauna and a foraminiferal horizon with *Ammodiscus* in the middle of the stage. The sequence grades upward into the sandstones of the Kennedy stage, and the boundary is drawn above the two highest horizons with *Calceolispongia* which contain a last, rather large, representative of the genus and the lamellibranch *Oriocrassatella* cf. *stokesi* Etheridge.

The Kennedy sandstone is rather poor in fossils. Near the base a horizon with *Chonetes* and *Streptorhynchus* was found at Wandagee Hill. Elsewhere, a few spiriferids and productids, as well as lamellibranchs, are known to occur in it. Raggatt and Fletcher list (1937, p. 170) six species in this stage and the final fossil list will be found to be only slightly longer.

Throughout the whole sequence from the base of the Wooramel to the top of the Kennedy sandstone numerous horizons with an abundance of invertebrate trails are noticeable. Two types prevail among these. One is similar to the Eocene *Bullia* trails described by Abel (1935, pp. 220–237) and almost certainly can be interpreted as trails of gastopods (Fig. 3); the other is of a large segmented type and is most probably the trail of a large mud-eating worm (Fig. 4). In addition, trails of the "Nereites" type and numerous other trails can be found.

The sequence of Bulgadoo-Cundlego-Wandagee must, in a general way, correspond with the Byro series of the Gascoyne River. It is as yet unknown whether the Wandagee series is absent on the Gascoyne or is replaced by an unfossiliferous facies. There is no indication of the typical facies of the Wandagee series along the foot of the northern part of the Kennedy Range, which the writer visited in 1940, but fossils of middle Wandagee age have recently been obtained from near the foot of the southern end of the Kennedy Range on Mooka Station.[4]

Further indications of the Wandagee series have been found near the southern extremity of the upper Paleozoic belt, south of the Wooramel River on Byro Plain, where *Calceolispongia* has been found by Rudd[5] and by the writer. Here also, numerous fossiliferous horizons occur in which large spiriferids, such as *Spirifer rostalinus*, are noticeable, but the section has not yet been examined in detail.

Raggatt has drawn attention (1936, pp. 146–47) to the possible existence of Paleozoic beds above the Kennedy sandstone which, at present, are known only in bores. If the age of the bore cores has

[4] The writer is indebted to L. Glauert for showing him these fossils which have been sent in recently to the Western Australian Museum and Art Gallery.

[5] Specimens in the Commonwealth Palaeontological Collection, Canberra.

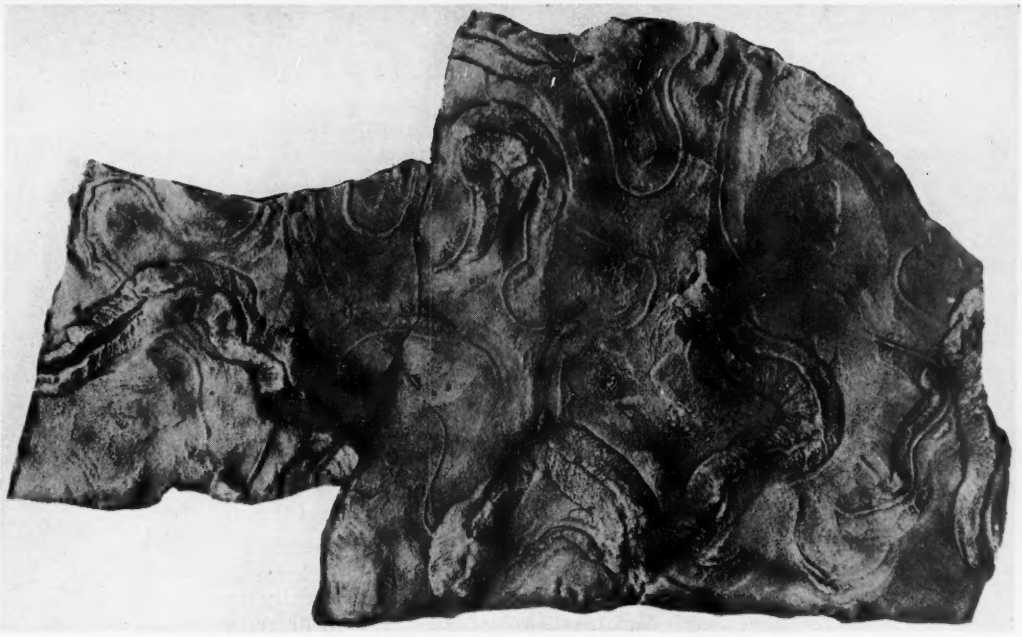

FIG. 3.—Segmented trail, probably made by large mud-eating worm. Uppermost part of *Calceolispongia* stage of Wandagee series. North side of Minilya River, in center of syncline west of Coolkilya Pool, Wandagee Station. ½ natural size.

FIG. 4.—Large gastropod trails. Upper Ferruginous series. First ridge north of Moulamen Hill, West Kimberley district. ½ natural size.

been correctly determined, there may be another 1,000–1,500 feet of Paleozoic sediments above the Kennedy sandstone.

WEST KIMBERLEY DIVISION

This is only part of a probably very large area of late Paleozoic rocks the extent of which has been shown very differently on recent maps (see Clarke, 1938b, p. 32). On the latest geological map of Western Australia by Blatchford (1934) and also on David's Geological Map of the Commonwealth of Australia (1932) this area is shown as a rectangle with its longer side extending approximately northwest and southeast. The northwest boundary of this area is formed by the younger formations of the coastal belt and extends from about 90 miles east of Port Hedland to 50 miles north of Derby—a distance of about 350 miles. From here the area of upper Paleozoic rocks is shown to extend inland for at least 400 miles and the size of the area underlain by these rocks would then be approximately 140,000 square miles. Actually, however, it is not known how much of this practically unexplored country consists of Paleozoic strata. More recently the area has been described in broad outlines by Clapp (1925, 1926), and some data have been collected by L. J. Jones (see Hobson, 1936). It has been crossed on very few occasions and the basins of the Fitzroy River and its tributaries, Christmas Creek, and Margaret River, are the only parts which are now known in some detail. This explored area covers about 20,000 square miles.

The sequence is, of course, not quite uniform throughout this area. The thicknesses vary and changes in facies occur. In general, however, the sequence can be characterized as follows (after Wade, 1936 and 1938).

	Feet
Erskine series. Estuarine conglomerates, grits, sandstones, and shales with plants	350
Upper Ferruginous or *Liveringa series.* Clays, grits, sandstones, ordinarily limonitized, with rich marine fauna	1,400
Nooncanbah series. Clays, shales, with calcareous horizons, many of them passing into sandstone. Rich marine fauna	1,200
Lower Ferruginous series. Coarse, dark grits and conglomerates, sandy shales and flags, ordinarily heavily limonitized. Rich flora	2,200
Nura Nura limestone. Gray, sandy limestone with erratic boulders. Arenaceous shale. Fossiliferous	20+
Grant Range series. Sandstones, grits, arkoses, conglomerates, containing pebble beds and in places larger boulders. Boulder clays and tillites. Clayey sandstones. Massive Fontainebleau sandstones. Fossil wood	2,300
Kungangie series of Christmas Creek area. Fine-grained sandstones and clayey sandstones. Coarse red grits, sandy shales and cherts, probably also tillites and boulder clays. Fossil wood	2,000
Total	9,470+

Farther east toward the eastern boundary of the Paleozoic out-

crops the Kungangie series is replaced by boulder beds (J.8 beds) which rest on Devonian or pre-Cambrian. The maximum thickness of these beds is about 400 feet.

This sequence is underlain by rocks of Devonian age. The upper Middle Devonian is represented by stromatoporoid reefs and coral and brachiopod limestone and is overlain by sandy goniatite limestones, representing the lower half of the Upper Devonian (Oberdevonstufe I–III, see Teichert, 1940b) which in turn are followed by Crinoidal limestone. The gap between the Upper Devonian and the glacial beds of the Kungangie and J.8 series is, according to Wade, bridged by 1,000 feet of chocolate-colored clays and green-gray arenaceous and calcareous beds of doubtful (Carboniferous??) age. This series has not been found in outcrops and its presence is inferred from bore logs only. L. M. Waterford has pointed out to the writer that these strata might actually be Devonian which they indeed seem to resemble lithologically.

An important feature of the upper Paleozoic section—excluding these doubtful Carboniferous beds—is the great thickness (more than 4,300 feet) of glacial sediments which form the lower part of the series, and whose thickness exceeds considerably that of the glacial beds in the Irwin River district as well as in the North-West Basin. Marine fossils make their first appearance comparatively high in the sequence. The fauna of the Nura Nura limestone is not rich. It includes *Spirifer hardmanni* in addition to undescribed spiriferids, *Waagenoconcha*, and Bryozoa, and near the top there is a layer with limonitized fossils which include *Metalegoceras clarkei*, *Thallassoceras wadei*, described by Miller in 1936, in addition to a few nautiloids, lamellibranchs, and gastropods. *Metalegoceras clarkei*, it should be remembered, is not very similar to *Metalegoceras jacksoni* from the Irwin River (see Miller, 1932). It is a much smaller species with umbilical ribs in the early stages and with the external lobe closest to the umbilical shoulder much more strongly developed than in the Irwin River species. The rest of the Nura Nura fauna has not yet been studied in detail. The Nura Nura limestone occurs in patches in the main basin of the Fitzroy River as well as in the Margaret River and Christmas Creek areas and contains here boulders some of which are very large.

The lower Ferruginous series contains a flora of *Glossopteris*, *Vertebraria*, *Noeggerathiopsis*, *Lepidodendron*, and *Bothrodendron*. Invertebrate trails occur at some horizons, but these seem to be types different from those which occur in higher, marine horizons, notably in the upper Ferruginous series.

The Nooncanbah series is an extremely fossiliferous sequence of

strata. Bryozoa and Brachiopoda are the most prominent groups. Large spiriferids and productids (*Spirifer rostalinus* and *Taeniothaerus subquadratus*) are among the latter but a considerable number of additional species of *Spirifer*, *Streptorhynchus*, *Strophalosia*, *Cleiothyridina*, and other genera is known though as yet largely undescribed. The corals include *Thamnopora marmionensis* Etheridge, *Thamnopora immensa* Hill, and *Cladochonus nicholsoni* (Etheridge) and the crinoids include, so far, three species of *Calceolispongia*, with the holotype *Calceolispongia hindei* Etheridge which is characteristic of the top beds of the Nooncanbah series at Mount Marmion. No cephalopods and trilobites and few lamellibranchs have as yet been found. Paleontological zoning of the series has not yet been undertaken, but is undoubtedly possible. There are indications that some of the fossil zones of the Wandagee series of the North-West will be recognizable in the Nooncanbah series.

The upper Ferruginous (also called Liveringa) series is essentially characterized by brachiopods and lamellibranchs. Among the former group are *Streptorhynchus luluigui*, *Cleiothyridina royssii*, *Aulosteges spinosus*, *Taeniothaerus subquadratus*, and species of *Linoproductus*, *Waagenoconcha* and *Spirifer*. The lamellibranch fauna has not yet been studied, but it contains pectinids, *Stutchburia*, *Cardiomorpha*, *Schizodus*, and a considerable number of other genera. The gastropods include pleurotomarids, a large *Bellerophon*, similar to *Bellerophon blanfordianus* Waagen and *Conularia*. The "abundant, but poorly preserved cephalopods" listed by Wade (1936) belong to the bellerophontid *Warthia* which occurs in great quantities in certain beds of the upper Ferruginous series. Invertebrate trails are abundant in places. Prominent among them are trails similar to those in the sandstone series above the Callytharra limestone of the North-West: the *Bullia*-like gastropod trails, the segmented mud-eater trail (Figs. 3, 4), and the "Nereites" type. From the very highest beds of the upper Ferruginous series, Chapman and Parr (1937) described *Verbeekina* sp. and *Neoschwagerina* sp. These are the highest marine Paleozoic beds in the Kimberley district.

The sandstones of the Erskine series are rich in plant fragments, but poor in determinable remains. *Lepidodendron*, *Cordaites*, and *Phillotheca* have been doubtfully determined from this series.

WESTERN AUSTRALIAN CORRELATIONS

Prior to the publication of the writer's correlation table of the Western Australian upper Paleozoic formation in 1939 (p. 93) few attempts to arrive at a correlation of the various sequences had been

made. The first correlation to be proposed was that between the strata at Callytharra Springs, Wooramel River (now Callytharra limestone series) and those of the Fossil Cliff, Irwin River (now Fossil Cliff series) by L. F. Hosking in 1931 (p. 9). The evidence was accepted by Condit, Raggatt, and Rudd in 1936 (p. 1051) and in a publication by Raggatt of the same year. These authors also presented the first general correlation between the sequences in the Irwin River district and in the North-West. The Irwin River Coal Measures were correlated with the Wooramel sandstone and with the basal shaly part of the Byro series, the Irwin River upper Marine with the middle part of the Byro series (the equivalent probably of the Cundlego series of the Minilya River). The shales and mudstones of the *Metalegoceras* series were correlated with the non-glacial top part of the Lyons series and in the Irwin River glacials with the lower, glacial, part of the same series. In 1939, still under the impression that the Wandagee series, as suggested by Raggatt, formed the top of the sequence in the North-West, the writer correlated the Irwin River Coal Measures in a general way with the Byro and Kennedy sandstones of the North-West and the upper Marine with the Wandagee series.

Correlations between the Kimberley and the North-West sections have not been attempted until recently. According to Clarke (1938, p. 33) a correlation had been suggested between the Nooncanbah series and the Callytharra limestone. In 1939, the writer called attention to similarities between the Nooncanbah and the Wandagee series, and correlated the Callytharra limestone with the Nura Nura limestone of the Kimberley. Further proof of the correctness of the correlation of the Wandagee with the Nooncanbah has been accumulated since then, although alterations are necessitated by the change of the place in the succession of the Wandagee series from above the Kennedy sandstone to a position below it.

IRWIN RIVER-NORTH-WEST CORRELATION

The outstanding feature is the correlation of the Callytharra and Fossil Cliff series which have many species in common. Among the corals are *Plerophyllum australe*, among the brachiopods are the productids (Prendergast, 1941), *Dictyoclostus callytharrensis*, and *Strophalosia etheridgei*, and a species of *Syringothyris*. Furthermore, the two series contain several identical species of Bryozoa and one undescribed crinoid. It will be possible to characterize the similarities still more fully when the faunas have been studied in more detail.

This correlation having been established, the conclusion is justified that the Irwin River tillite and the beds of the *Metalegoceras* stage are

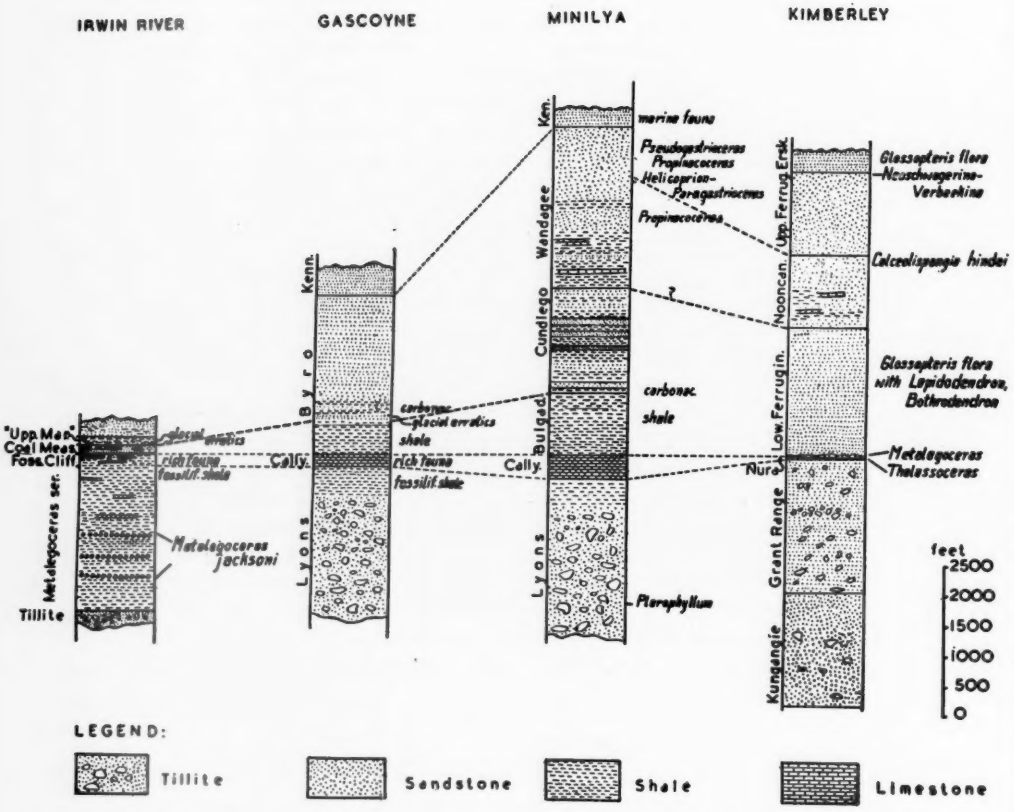

FIG. 5.—Diagrammatic representation of some important sections of upper Paleozoic rocks in Western Australia.

the equivalent of the Lyons River series of the North-West. It is furthermore likely that the 2,500 feet of the non-glacial *Metalegoceras* series represent more time than the 500 feet of non-glacial fossiliferous shales in the upper part of the Lyons series, since general field evidence suggests rather more rapid sedimentation in the North-West than in the Irwin River district. The *Metalegoceras* series, therefore, must also correspond with the upper part of glacial sediments of the Lyons series. It must, therefore, be concluded that although glacial sedimentation in both districts started before the time of *Metalegoceras jacksoni*, it was still in progress in the North-West when the sediments with *Metalegoceras jacksoni* were laid down at the Irwin River.

No direct data are available for the correlation of the sequence in both districts above the Callytharra-Fossil Cliff series. It is, however, reasonable to conclude with Condit, Raggatt, and Rudd (1936, p. 1052) that the Irwin River Coal Measures correspond with the lower, shaly part of the Byro series and probably also include equivalents of the Wooramel sandstone which can be compared with the much thinner, coarse-grained, cross-bedded sandstone at the base of the Irwin River Coal Measure series. The equivalent in the Minilya River section would be Wooramel sandstone and Bulgadoo series.

The Irwin River upper Marine must then correspond with the higher marine strata (upper Byro and Cundlego plus Wandagee) in the North-West, although its thickness is only a fraction of the thickness of those series. The uppermost sandstone series of the Irwin River is lithologically somewhat reminiscent of the Kennedy sandstone but such a correlation must be accepted with considerable caution since no paleontological data are available to support it. Both the upper Marine and the higher sandstones might not correspond with more than a small part of the North-West section above the basal Byro or Bulgadoo series and sedimentation at the Irwin River might have ceased much earlier than in the North-West.

KIMBERLEY–NORTH-WEST CORRELATIONS

The correlation between the Wandagee of the North-West and the Nooncanbah of the Kimberley, which was suggested by the writer in 1939, can now be regarded as sufficiently well established, although there is as yet little published evidence to refer to. Higher parts of the Wandagee series which were discovered in 1940 include equivalents of part of the upper Ferruginous series of the Kimberley.

The boundary between the Nooncanbah and the upper Ferruginous is well exposed at Mount Marmion, about 45 miles from Derby and about the same distance north of the Fitzroy River. The top beds

of the Nooncanbah series contain here *Thamnopora marmionensis*, *Calceolispongia hindei*, a very robust species of *Taeniothaerus*, probably a variety of the large *Taeniothaerus subquadratus* of the Wandagee series, and *Spiriferella australasica*.[6] This assemblage is very suggestive of the fauna of the lowest part of the *Linoproductus* stage of the Wandagee series from which *Thamnopora* aff. *marmionensis* and the closely related *Thamnopora immensa* is known. This latter species also occurs high in the Nooncanbah in the Christmas Creek area. *Spiriferella australasica* is associated with *Thamnopora* in the same beds of the Wandagee series. *Calceolispongia hindei* is not known from the Wandagee series, but the general state of development of this species suggests contemporaneity with the as yet undescribed advanced species of the same genus in the lower *Linoproductus* stage of the Wandagee.

Calceolispongia may yet turn out to be an important index fossil of the Nooncanbah series. One mile east of Nooncanbah Homestead, in beds which represent a lower horizon of the Nooncanbah series than that present at Mount Marmion, the writer found associated two species which are characteristic of the middle part of the *Calceolispongia* stage of the Wandagee and the accompanying fauna of productids and spiriferids gave support to this correlation.

Among the productids common to the Kimberley and North-West beds are (Prendergast, 1941) *Waagenoconcha vagans* from the Liveringa series and from the *Linoproductus* stage of the Wandagee, *Strophalosia kimberleyensis*, a common fossil in the Nooncanbah, upper Ferruginous, and Wandagee strata, and *Etheridgeina muirwoodi* from the upper Nooncanbah at Mt. Marmion and from the Wandagee beds.

In the lower part of the upper Ferruginous, which is exposed on Lower Liveringa Ridge, a large, undescribed species of *Cleiothyridina* is common and the same species is commonly found in great numbers above the *Thamnopora-Spiriferella* zone of the lower *Linoproductus* stage. It is most likely that the boundary between the Nooncanbah and the upper Ferruginous must be drawn through the lower part of the *Linoproductus* stage in the North-West. The highest 700 feet or so of the Wandagee series must still be equivalents of some part of the upper Ferruginous, and the Kennedy sandstone with its poor fauna of productids, spiriferids, and lamellibranchs either corresponds with the top part of the upper Ferruginous or may be considered as the

[6] Records of the occurrence of this species in the Callytharra and Fossil Cliff faunas should be discounted. The specimens thus determined belong to another, undescribed, species.

marine equivalent of the Erskine series. Since there is no break in the sequence between the Wandagee and the Kennedy and the fossil assemblage of the latter contains no forms very different from those in the underlying formations, the writer would like, at present, to favor the former alternative.

It is as yet impossible to say if the base of the Nooncanbah corresponds with the base of the Wandagee. It is possible that the Nooncanbah goes low enough to include equivalents of the higher part of the Cundlego series, but no evidence is available one way or the other. The stratigraphical position of the lower Ferruginous series with its rich *Glossopteris* flora suggests correlation with strata below the Wandagee series either with all or part of the Cundlego series and with the Bulgadoo series and with the lower part of the Byro of the Gascoyne River section. These strata have, in the previous section, been correlated with the Irwin River Coal Measures. The resulting correlation of the lower Ferruginous with that series is in complete harmony with the evidence furnished by the flora.

As regards the Nura Nura limestone there are hardly any data to support its correlation with any of the southern strata, except the occurrence of *Spirifer hardmanni* which is a common fossil of the Callytharra and Fossil Cliff series. The occurrence of *Metalegoceras clarkei* in the Nura Nura is not suggestive of a correlation with the *Metalegoceras* beds of the Irwin River. As has been pointed out, *Metalegoceras jacksoni* of the Irwin River is a more primitive species and, if anything, should be older than *Metalegoceras clarkei*. No better suggestion, then, can be made at present than to correlate the Nura Nura with the Callytharra of the North-West and with the Fossil Cliff of the Irwin River. All three formations contain the first important marine faunas that invaded their respective districts in Western Australia after the deposition of the main glacial series of sediments.

It has been pointed out in a preceding paragraph that these glacial sediments are considerably thicker in the Kimberley district than in either of the two other areas. The writer has previously suggested (1939) that this might be due to an earlier beginning of glacial sedimentation in the north, but it might equally well be caused by more rapid accumulation of sediments. For the present it is, therefore, impossible to establish definitely whether or not glacial sedimentation commenced simultaneously in all parts of Western Australia.

PALEOGEOGRAPHICAL CONCLUSIONS

It seems certain that when the Irwin River tillites were being formed, similar deposits were accumulating in the North-West and

Kimberley districts, although it can not be asserted that glacial sedimentation began at the same time everywhere in Western Australia. In the south (Irwin River) the formation of tillites marked but a short episode in the history of the area, and while glacial sedimentation was continuing in the northerly regions, the limestone and claystone series with *Metalegoceras* was formed in the Irwin River country. Woolnough (1937, 1938) has suggested that this limestone and claystone series was deposited in a barred basin with highly saline waters, unfavorable to marine life. On the lee shore of the bar great numbers of *Metalegoceras* shells were piled up and occasionally swept into the basin. Woolnough's theory would not only explain the general scarcity of fossils which contrasts with the abundance of *Metalegoceras* at certain restricted horizons; it would also help to understand the absence of ice-borne material from this series. No glaciers would have reached the Irwin River Basin at this time and icebergs of some distant origin were carried away outside the bar and were not able to penetrate into the basin.

At a still later stage (upper part of Lyons series) glacial sedimentation also ceased in the North-West, but was still going on in the Kimberley, where it continued all through the time when the Fossil Cliff and Callytharra limestones were formed in the south. A general increase in the temperature of the water is indicated by the gradual arrival of the Fossil Cliff and Callytharra faunas and the final occupation of the two southern districts by these rich faunas. The rather poor fauna of the Nura Nura limestone indicates that conditions in the north must have compared unfavorably with those in the south.

Glacial sedimentation now ceased altogether and the *Glossopteris* flora appeared in Western Australia. In the north and in the extreme south estuarine and lacustrine sedimentation ensued. Sandstones, at the Irwin River interbedded with a few coal seams, contain a rich flora which in both districts indicates a slight intermingling of predominant *Glossopteris* elements with sporadic "arctocarbonic" forms (*Lepidodendron, Bothrodendron*). Plant beds are absent from the intermediate area where sedimentation at this time continued to be marine. Plant fragments and fossil drift wood in the lower Byro and Bulgadoo series, however, indicate the existence of at least fairly normal vegetation near the shores of the sea. Among the driftwood in the lower Byro there is also a fragment of *Lepidodendron*. Apparently, north of the Irwin River the coast line must have swung eastward and have run well to the east of the present North-West Basin.

The general period of marine sedimentation that followed may not have commenced simultaneously in the north and in the south.

The great thickness of the lower Ferruginous in the Kimberley suggests that estuarine or lacustrine sedimentation continued in the north after the Irwin River Coal Measures had been formed. At this time glacial sedimentation, though on a slight scale, is again evident in the Irwin River upper Marine and also in the middle Byro of the North-West.

Rich faunas now began to populate the North-West and Kimberley districts. Sedimentation was predominantly detrital and many thousands of feet of sediments were deposited in rapid succession. Rapid rate of sedimentation is suggested by the comparatively slight changes of faunas in the series (Cundlego-Wandagee and Nooncanbah-upper Ferruginous), also by the abundance of invertebrate trails and markings all through these series which stand slight chance of preservation, unless they are quickly covered by incoming sediment. In the North-West there is a marked increase in abundance of life throughout these series.

It is very probable that during this period the sea spread to an area just outside the Western Australian boundary, that is, to the coastal region between the Victoria and Daly rivers in the Northern Territory of Australia. In 1907, Etheridge described a fauna derived from beds in this area which seems to have many species in common with the higher marine series of the North-West and Kimberley districts. The detailed stratigraphy of that country is, however, unknown.

It is impossible to give even an approximate picture of the later paleogeography. It is not known at what time the highest sandstone series at the Irwin River was deposited. The unfossiliferous nature of the sediments suggests non-marine conditions. After the short incursion of "upper Marine" time the sea might have retreated soon and the upper sandstones might have been deposited in lifeless lagoons at a time when abundant marine life flourished in the seas of the North-West and Kimberley districts.

In the Kimberley marine sedimentation came to an end with the deposition of the *Verbeekina-Neoschwagerina* beds of the upper Ferruginous. It can not yet be said, whether marine sedimentation ceased at the same time in the North-West or whether the highest marine beds of the North-West (Kennedy sandstone) are an equivalent of the lacustrine Erskine series of the Kimberley which forms the top of the Paleozoic sequence in that part of Western Australia. At any rate, the existence of the *Glossopteris* flora in Western Australia is still evident during Erskine time when it was probably again—or still—intermingled with northern types of flora.

There is little doubt that it will ultimately be found that the major-

ity of the marine faunas of the North-West and Kimberley districts consist of identical species. These close similarities suggest that the sediments of both areas, though now divided by the pre-Cambrian block of the Pilbara district, were deposited in one continuous basin with free communication and interchange of faunas over its whole length. This, together with the fact—to be discussed more fully later—that a very considerable thickness of sediments were accumulated during a comparatively short time, shows this basin as an important structural unit with geosynclinal characters which the writer has proposed to call the "Westralian geosyncline." As early as 1930 Forman had described the Desert Basin as a "geosynclinal unit." The rate of accumulation of sediments during the relatively short Paleozoic history of the Westralian geosyncline exceeded that of many parts of the Tasman geosyncline of eastern Australia.

Wade has recently (1939, p. 90) reproduced and accepted a map by the late R. J. Tillyard which gives an interesting interpretation of Australian paleogeography during Permian time. It is thought that the Kimberley sedimentary trough continues southward into a depression, the "Tethynotian channel." It is not expressly stated, whether this channel should be imagined as a water way or as low dry land, but east of this depression mountainous country is visualized, whence glaciers descended to the Tethynotian channel which thus provided a way by which ice could enter the Kimberley trough. Although this is not mentioned in Wade's short abstract, accompanying the map, Wade and Tillyard apparently correlate the boulder beds of the Wilkinson Range with the glacials of the Kimberley trough. These beds were discovered by Talbot and Clarke (1917) in Western Australia close to the South Australian boundary. No direct evidence as to their age is available and Talbot and Clarke thought that they might be late Mesozoic or Tertiary.

The Kimberley trough and the Tethynotian channel are, according to Wade and Tillyard, bounded on the west by an elongate landmass called "Hesperonotia," comprising all the country between the channel and the coastal districts of Western Australia and projecting northward and southward beyond the present coast line. West of Hesperonotia was the sea in which the sediments of the Irwin River district and the North-West were laid down. This sea narrowed southward to a narrow strait, the "Stirling channel," between the southern part of Hesperonotia and a land tongue, the "Leeuwin Land," which was linked with Madagascar.

This paleogeographic reconstruction is probably not correct in all details, but the general picture seems acceptable. While on the Wade-

Tillyard map there is free communication between the Kimberley trough and the Timor sea, the former is separated from the North-West Basin by a long projection from Hesperonotia, whereas our discussion of the faunas of these two regions has shown that free communication must have existed between them. This means that Hesperonotia can not have extended as far to the north as Wade and Tillyard suppose. As regards the Stirling channel, there is no evidence as to the age of the sediments occupying the trough between the Leeuwin pre-Cambrian complex and the main mass of the West Australian shield.

CORRELATION WITH EASTERN AUSTRALIA

In regard to the correlation of the Western Australian sequence with that of the eastern Australian Kamilaroi system the fossil evidence so far available is most inconclusive (see Raggatt and Fletcher, 1937, pp. 171–178). Most eastern species reported from Western Australia have a long range and the evidence furnished by short-lived species is contradictory. Thus, upper Marine forms (*Pherophyllum gregorianum*) have been recorded from the Callytharra, and Burindi (lower Carboniferous) species (*Orthotetes crenistriata*) from the Byro, but such discrepancies will undoubtedly disappear, once the Western Australian faunas have been studied in detail. On the other hand, it is becoming increasingly evident that the differences between lower and upper Marine faunas in New South Wales are not very outstanding (Raggatt and Fletcher, 1937, p. 155) and that, therefore, the eastern Australian marine sequence does not represent much of Permian time, as was already suggested by Schuchert in 1935 (p. 33). On the whole it would seem that there is little similarity between the eastern and western upper Paleozoic faunas, as was suspected by Koken as early as 1907. The wide separation of both areas by a large continent easily accounts for this, and to explain these differences it is probably not necessary to have recourse to the correlation of marine strata in Western Australia with fresh-water stages in the east, as was once suggested by Whitehouse (1928, p. 283). The Bowen series in Queensland seems to contain a few species of corals and brachiopods identical with Western Australian species, such as *Euryphyllum reidi*, *Thamnopora immensa*, and *Cladochonus nicholsoni* as recorded by D. Hill (1941) and *Taeniothaerus subquadratus* (Whitehouse, 1928). Whitehouse remarks in general on the occurrence of middle Bowen species in Western Australia, and among the corals previously mentioned, *Cladochonus nicholsoni*, an upper Nooncanbah species, is known from the Coral stage in the upper part of the lower Bowen. It is

also worth mentioning that the only Australian record of Permian ammonoids outside Western Australia comes from Queensland, where Whitehouse (1925, p. 474) recorded an "impression of a cephalopod (?) resembling *Girtyites*" from the Homevale beds of the lower Bowen at Mt. Britton. This reference might refer to a true *Paragastrioceras* such as is found in the lower *Linoproductus* stage of the Wandagee series of Western Australia. David, in fact (1932, Table D) referred to these Queensland beds as "*Paragastrioceras* (?) beds of Mt. Britton."

It is an interesting fact, already noticed by Raggatt and Fletcher (1937, p. 182) that *Eurydesma* is apparently absent from Western Australia. The reason for this is not obvious. *Eurydesma* is usually regarded as a typical cold-water fossil. Yet, it is absent from the glacial deposits in Western Australia and it is found in the non-glacial lower Bowen series of Queensland. Two specimens from the Byro series (?) of the Wooramel River country in the Oil Search Collection kept in the Commonwealth Palaeontological Collection at Canberra have been determined by F. Chapman as *Eurydesma cordatum* and O. Fletcher thinks that this identification may be correct. The specimens are immature individuals and additional material will be necessary before the occurrence of *Eurydesma* in Western Australia can be definitely established.

However, even in the absence of reliable paleontological data there are certain outstanding features in the succession in various parts of Australia to which attention should be called. Even if one is disinclined to stress the importance of diastrophism in correlation, *there is a remarkable rhythm of sedimentation in most parts of Australia.* The most complete Western Australian succession of strata, as found in the Kimberley district, in a general way shows great similarity with that of New South Wales. The double rhythm above the basal tillites of marine and continental strata (lower Marine-lower Coal Measures-upper Marine-upper Coal Measures) corresponds with conditions in the Kimberley district and from this point of view the correlation set forth in Figure 6 has been suggested. A somewhat similar correlation had already been proposed by David in 1932 (Table E) on the basis of less complete information available at that time. In the Queensland section the marine, non-glacial, lower Bowen series is followed by the fresh-water beds of the lower middle Bowen and in turn by the marine strata of the upper middle Bowen which contain one glacial horizon. The sequence closes with the fresh-water upper Bowen series.

In spite of the many local variations in the Tasmanian sequences,

Some Australasian UPPER PALAEOZOIC Correlations

U. S. S. R.	Salt Range	Peninsul. India	Sumatra	Timor	Western Australia			N. S. Wales
					Kimberley	North-W.	Irwin R.	
	Middle				ERSKINE Sandst.			Base of Upper Coal Meas.
KUNGURIAN	Productus Limestone	BARAKAR SERIES		Basleo Beds	Upper Ferruginous	Kennedy sandst.		UPPER MARINE SERIES Mulbring
	Lower			Bitaoeni	Nooncanbah	Wandagee	Unfossilif. sandstones	Muree
ARTINSKIAN	Productus Limestone		Gigantopteris Flora of Karing Beds	Beds	Lower Ferruginous	Cundlego BYRO SERIES of Gascoyne River Bulgadoo	"Upper Marine" Coal Measures	Branxton Greta Coal Meas.
		Umaria Beds			Nura Nura ls.	Wooramel sandst. Callytharra ls.	Fossil Cliff ls.	Farley Stage
SAKMARIAN	Speckled Sandstone Talchir Tillites	Talchir Series	Telok Gedang Fauna	Somohole Beds	Grant Range Series Kungangie Series	non-glacial shales Lyons Tillite Series	Metalegoceras Stage Tillites	LOWER MARINE SERIES Allandale Lochinvar

FIG. 6.—Some Australasian upper Paleozoic correlations.

described by Voisey (1938), the same rhythm is noticeable almost everywhere in Tasmania: glacial beds at the base, followed by richly fossiliferous beds (Granton stage of southern Tasmania, lower Latrobe stage of northern Tasmania, *et cetera*) in turn followed by fresh-water beds and Coal Measures (Porter's Hill stage of southern Tasmania, Mersey Coal Measures of northern Tasmania, Mt. Pelion Coal Measures of western Tasmania). In some parts of Tasmania the fresh-water beds are overlain by marine beds (Grange, Woodbridge, Lindisfarne stages of southern Tasmania, upper Latrobe of northern Tasmania) and these marine beds are in southern Tasmania followed by the Cygnet Coal Measures which form the top of the sequence.

Voisey cautiously refrains from detailed correlation between the Tasmanian section and that of New South Wales, but on the other hand the close analogies in the sequences of widely separated parts of Australia can hardly be accidental. The North-West Basin of Western Australia is the only region in Australia where the upper Paleozoic is represented by an entirely marine facies.

With these considerations in mind, it is proposed to correlate in a general way all Western Australian series up to and including the Fossil Cliff, Callytharra, and Nura Nura series with the lower Marine of New South Wales, the Irwin River Coal Measures, the lower Byro, Bulgadoo, and lower Ferruginous series with the lower or Greta Coal Measures, the Irwin River "upper Marine," the upper Byro, Cundlego, Wandagee, Nooncanbah, and upper Ferruginous series with the upper Marine, and the Erskine (and possibly Kennedy) series with the upper Coal Measures.

This proposed correlation does not imply that, for example, the sedimentation of the lower Ferruginous in the Kimberley commenced at exactly the same time as that of the lower Coal Measures in New South Wales, nor that the period of sedimentation of these two series coincided completely. It implies, however, that earth movements which brought about the end of marine sedimentation occurred at approximately the same time in the Kimberley district, in New South Wales and elsewhere in Australia, although there must have been differences in the rate and duration of such movements in different parts of the continent.

The evidence of the distribution of glacial sediments is not in disagreement with this proposed correlation. Conditions of glacial sedimentation in New South Wales are evident throughout the Lochinvar and Allandale stages of the lower Marine. In the Kimberley district glacial conditions continued to the end of lower Marine time. Then followed the interglacial break of lower Coal Measure time, when the

lower Ferruginous, the Bulgadoo, lower Byro, and Irwin River Coal Measures were formed in Western Australia. Glacial sedimentation is again prominent through almost all the upper Marine in New South Wales, and occurrences of glacial sediments are recorded from the Irwin River "upper Marine," from the middle Byro, and also from the upper middle Bowen of Queensland as well as from the Woodbridge glacial stage of southern Tasmania. It is, however, not proposed to correlate strictly the "upper" glacial horizons in Western Australia, Queensland, and Tasmania. The sediments of the upper Marine in New South Wales show that conditions for glacial sedimentation were present throughout this time and the glacial horizons in the other states might have been formed at any time during this period. On the other hand, it is conceivable that the horizons mentioned may mark a time of deterioration of climate and increase of glaciation in which glacial sedimentation spread to areas outside New South Wales which were normally not affected.

FOREIGN CORRELATIONS

Although the Carboniferous-Permian boundary has been much discussed in recent literature, the present state of affairs is far from satisfactory as is best illustrated by looking through the abstracts of the papers on this subject presented to the International Geological Congress at Moscow, 1937 (see also Williams, 1938). Unless an author defines clearly his conception of the terms "Carboniferous" and "Permian" mutual understanding is made difficult. Expressions like "lower Permian" and "middle Permian" have become ambiguous, and Elias' proposal (1937, p. 210) to use preliminary designations such as "Uralo-Permian" and "Artinsko-Permian" to indicate whether or not an author is prepared to include the Uralian and its equivalents in the Permian seems to have gained little support. Dunbar has recently (1940) given a lucid account of the problems involved in the question of the Permo-Carboniferous boundary and in a very precise manner contrasted the underlying philosophy of two schools who approach these problems each in its own way. The one to which Professor Dunbar himself belongs, "believes that the larger stratigraphic units are natural, at least in large parts of the world, being separated by hiatuses due to widespread (though not necessarily universal) continental emergences." To the other school a geological system is an artificial unit and any boundary is satisfactory so long as it is agreed upon by all or at least by a majority of specialists in that particular field. The case for this latter school to which the writer personally adheres has been most ably stated by Pia in a paper in 1937.

In order to achieve conformity with the opinion of a majority of American geologists and of a number of Soviet geologists, the Carboniferous-Permian boundary will in this paper be drawn below the Sakmarian.

The question of how much, if any part of the "Permo-Carboniferous" sequence in Australia must be assigned to the Carboniferous and how much to the Permian is being increasingly discussed, and was given special attention at the Canberra meeting of the Australian and New Zealand Association for the Advancement of Science in January, 1939. It has long been customary to assign the main glacial series at the base of the New South Wales sequence to the Carboniferous, a view in later years still maintained among others by David (1932) and by Du Toit (1937). On the other hand, Raggatt and Fletcher, in 1937, advocated the inclusion of all the New South Wales section in the Permian, as had already been done by Schuchert (1928, 1935), and the same claim was made with regard to the Kimberley section by Wade in 1938. Furthermore, Raggatt and Fletcher claimed that no Carboniferous was represented in the North-West Basin of Western Australia and that lower, middle, and upper Permian were represented here. They did, however, omit to state which interpretation of the Carboniferous-Permian boundary they were prepared to adopt. Clarke (1938a) was the first to indicate that there might be a great thickness of Artinskian beds in Western Australia, and in 1939 and 1940 (p. 142), the writer suggested that no marine faunas younger than Artinskian were represented in Western Australia, and probably in Australia in general, a view which was also supported by Raggatt (1939). Dorothy Hill, in the same year, maintained that all pre-Artinskian strata of Australia should still be included in the Carboniferous.

Without further preliminaries the writer proposes now to weigh the evidence afforded by Western Australian faunas which contain some groups of fossils well suited to the purpose of foreign correlation.

Perhaps the most important index fossil of Western Australia is *Helicoprion davisii* which occurs near the base of the *Linoproductus* stage of the Wandagee series in the North-West. This horizon is about 7,500 feet above the base of the upper Paleozoic sequence in the North-West. Elsewhere the writer has discussed (1940a) the close relationships between *Helicoprion davisii* and *Helicoprion bessonowi* from the Artinskian of the Urals and there can be little doubt that the *Helicoprion* bed of the Wandagee series is Artinskian in age. This is also supported by the occurrence of typical *Paragastrioceras* at approximately the same horizon, a genus which, in its restricted sense, is elsewhere known only from Artinskian beds of the Ural Mountains (see Miller and Furnish, 1940, p. 84).

Helicoprion occurs in strata which are here regarded as the equivalents of the highest part of the Nooncanbah series of the Kimberley district. Above this horizon there are more than 1,000 feet of marine sediments in the North-West and about 1,400 feet of marine sediments in the Kimberley district. In the North-West there is no appreciable change of fauna in these higher beds. New species of brachiopods and corals are introduced, but on the other hand numerous brachiopods seem to continue throughout the series, for example, *Dictyoclostus gratiosus* which occurs at horizons of the *Calceolispongia* and of the *Linoproductus* stage. Also, the foraminiferal fauna of the *Linoproductus* stage has species in common with earlier stages of the Wandagee series. A species of *Propinacoceras* which appears in the *Calceolispongia* stage is still found in the middle *Linoproductus* stage. The continuity of the fauna is such as to make an Artinskian age also for the remainder of the *Linoproductus* stage above the *Helicoprion* bed the only likely assumption, whereas the paleontology of the Kennedy series is as yet too insufficiently known to allow any definite correlation. There is, however, no stratigraphical break between the Wandagee and Kennedy series.

Unfortunately, the exact sequence of fossil zones in the upper Ferruginous series of the Kimberley district has not yet been worked out. Since at least the lower part of the upper Ferruginous must be regarded as an equivalent of the *Linoproductus* stage in the North-West, an Artinskian age must be assumed for this part of the upper Ferruginous. The upper Ferruginous series closes, however, with beds containing *Verbeekina* and *Neoschwagerina*, two genera indicating a post-Artinskian age of these strata. It is true that Thompson (1936b) thought that *Verbeekina* must have originated in the "middle Permian" (Artinskian), but so far no species of this genus are known from that time. *It is therefore most likely that the Artinskian-Kungurian boundary must be drawn somewhere through the upper Ferruginous* and this boundary may coincide with the boundary between the Wandagee and Kennedy series in the North-West. At any rate, the writer's previous statement that no marine strata younger than Artinskian in age are represented in Western Australia must now be amended to read that only a small thickness of strata at the top of the marine sequence in Western Australia is younger than the Artinskian. Only a few hundred feet of sediments are involved and there is no indication of a stratigraphical break between Artinskian and post-Artinskian strata. *Marine sedimentation must have come to a close soon after the end of Artinskian time.*

The next question is: when did sedimentation in Western Australia begin? The lowest glacial beds are everywhere unfossiliferous. How-

ever, at the Irwin River *Metalegoceras jacksoni* makes its first appearance about 1,000 feet above the base of the glacials. It has been suggested in a preceding paragraph that the *Metalegoceras* beds of the Irwin River were laid down at the same time as the upper part of the tillites of the Lyons series and as the upper glacial series (Grant Range beds) of the Kimberley district. *Metalegoceras* is a characteristic fossil of the Sakmarian as well as of the Artinskian and Ružencev (1936, p. 495) reports the occurrence of a "*Metalogoceras jacksoni* Eth. n. var." in dolomites of Artinskian age from the Aktiubinsk district of the Ural Mountains, so that the *Metalegoceras* beds of the Irwin River, although stratigraphically about 6,500 feet below the *Helicoprion* horizon of the North-West, might still be Artinskian in age. On the other hand, it must be remembered that *Metalegoceras jacksoni*, as Miller (1932) has pointed out, is a rather primitive representative of the genus in that the pair of lobes just dorsal of the umbilicus is less developed than in other species of the genus. Since then, Ružencev (1938, p. 278) has described a still more primitive species from beds of middle Sakmarian age (*Metalegoceras distale*). The state of development of *Metalegoceras jacksoni* suggests, therefore, a Sakmarian rather than an Artinskian age of the *Metalegoceras* beds of the Irwin River. This is also the opinion of Miller and Furnish who have recently stated their opinion (1940, p. 26) that *Metalegoceras jacksoni* "presumably is Lower Permian"—that is, Sakmarian. Also, the great thickness of strata involved (more than 7,000 feet from the lowest *Metalegoceras* horizon to the top of the Wandagee series) makes it seem likely that more than the Artinskian only is represented in Western Australia. The question where the boundary between the Sakmarian and the Artinskian could be drawn in this country will be discussed later. It is not possible to say whether the beginning of glacial sedimentation in Western Australia coincided exactly with the base of the Sakmarian. It must be recalled that it is not even certain whether glacial sedimentation commenced simultaneously everywhere in Western Australia, but it can be assumed with some degree of confidence that *the processes which led to the deposition of glacial sediments began to operate somewhere around the beginning of Sakmarian time, that is, if the Sakmarian is accepted as the lowest member of the Permian system, glaciation began in very early Permian time or at a time only very slightly preceding the beginning of the Permian.*

The general evidence furnished by Western Australian faunas is in agreement with these conclusions.

Timor is geographically closer to Western Australia than any other area with well developed late Paleozoic faunas, but unfortunately

great differences exist in the composition of the faunas in these two areas. An excellent account of the Timor fauna has been given by Wanner in 1926. Echinoderms and cephalopods are among its most prominent groups and with a few significant exceptions, both are but sparsely represented in Western Australia where a brachiopod and bryozoan facies predominates. Owing to our incomplete knowledge of Western Australian faunas it is not yet possible to appreciate these differences properly.

The crinoid *Calceolispongia* is common in Western Australian and Timor beds and is elsewhere known only from the marine Umaria stage in the lower Barakar of Peninsular India. In Timor the genus is represented by a number of species in the Bitaoeni and Basleo beds. However, the evolutionary trend of the genus in Timor and Western Australia is different. *Calceolispongia cornuta* from the Bitaoeni beds is very similar to an undescribed species in the *Calceolispongia* stage of the Wandagee series, but in later beds the species diverge greatly in both areas.

Metalegoceras is known from the Somohole and Bitaoeni, but not from the Basleo, of Timor, and is most prominent in the basal part (Lidak zone) of the Bitaoeni (Simons, 1940, p. 128) but none of the Timor species is very similar to any of the Western Australian species. In Western Australia, the genus is restricted to the "lower Marine," namely, to the *Metalegoceras* beds of the Irwin River and to the Nura Nura limestone of the Kimberley. The "upper Marine" ammonoids of Western Australia belong to species of *Propinacoceras*, *Pseudogastrioceras*, and *Paragastrioceras*. The first two genera have a comparatively long range in the Permian, but are particularly abundant in Artinskian and slightly younger deposits. *Paragastrioceras* is restricted to the Artinskian.

As regards the corals, D. Hill (1941) points out the resemblance in a general way between the Western Australian species and those of the Bitaoeni and Basleo of Timor, but no identical species are known from these regions.

Among the productids (Prendergast, 1941), *Dictyoclostus gratiosus* is common to the Wandagee series, the Bitaoeni and Basleo beds, and to the middle *Productus* limestone of the Salt Range of India, *Dictyoclostus spiralis* is found in the Callytharra series, the Basleo beds, and in the lower *Productus* limestone, *Waagenoconcha vagans* in the upper Ferruginous series and in the middle *Productus* limestone, *Waagenoconcha imperfecta* in the upper Ferruginous series and in the Basleo beds and *Strophalosia tenuispina* in the Fossil Cliff limestone, in the Chonetes bed at Amb, and in the lower *Productus* limestone.

In general, it may be concluded that equivalents of the Somohole, Bitaoeni, and some part of the Basleo are found in Western Australia. Also it seems probable that equivalents not only of the lower, but also of the middle *Productus* limestone are represented in Western Australia. The latter is the approximate equivalent of the Basleo of Timor (Wanner, 1931). In addition to the brachiopods mentioned the bryozoan *Dybowskiella* can be quoted which does not appear in the Salt Range before the middle *Productus* limestone and which is listed by Raggatt and Fletcher (1937, p. 171) from the Callytharra and basal Byro beds. It also occurs in the *Linoproductus* stage of the Wandagee. In spite of the tendency in recent correlation tables (Fox, 1930; Schuchert, 1935) to correlate the upper Marine of New South Wales with the lower *Productus* limestone it is more likely that the higher parts of the marine sequences in eastern and western Australia also include some equivalents of at least the lower part of the middle *Productus* limestone, for example of the *Bellerophon* bed at the base of this series. In this connection it may be significant that Bellerophontidae closely related to middle *Productus* limestone forms occur in numbers in the middle and higher parts of the Wandagee series. The presence of two identical species of productids in the lower *Productus* limestone and in the Fossil Cliff and Callytharra series suggests that these series should be included in lower *Productus* limestone correlates.

Reed, Cotter, and Lahiri (1930) have shown how gradually the *Productus* limestone fauna appears in the upper part of the underlying Punjabian (Speckled sandstone) and we are at once reminded of the similar gradual appearance of the Fossil Cliff-Callytharra fauna in the upper parts of the *Metalegoceras* and Lyons series.

The absence of the *Eurydesma* fauna from Western Australia makes correlation with eastern Australia and with the Salt Range somewhat difficult, but there can be little doubt that the *Metalegoceras* beds of the Irwin River are the equivalents of some part of the Punjabian, corresponding to the Speckled sandstone of the Salt Range and to the Agglomeratic shales of Kashmir. These series should then be of Sakmarian age and the boundary between the Sakmarian and Artinskian should, in Western Australia, be drawn beneath the Fossil Cliff, Callytharra, and Nura Nura series, for the base of the lower *Productus* limestone is marked by the arrival of *Parafusulina* (Dunbar, 1933, 1940) and is therefore undoubtedly Artinskian.

These conclusions find support in Walkom's correlation (1930, p. 166) of the lower Coal Measures of New South Wales with the middle Ecca of South Africa. The Ecca series is in a general way correlated with the lower *Productus* limestone (Schuchert, 1928; Fox, 1930), and

paleobotanical evidence thus points to a correlation of the upper part of the lower Marine and of the lower part of the upper Marine with the lowermost and the uppermost parts of the lower *Productus* limestone, respectively, leaving room for the higher upper Marine of Australia to be correlated with the lower part of the middle *Productus* limestone. Also, Gothan's conclusion (1931, p. 306) that the beginning of the *Glossopteris* is not earlier than Stephanian agrees well with the paleozoölogical evidence previously discussed. If the beginning of the glaciation is approximately early Sakmarian, the first occurrences of the *Glossopteris* flora in the Salt Range, Kashmir, and New South Wales are late Stephanian in the continental time-scale. This conclusion applies only to the well defined floras which appear at some distance above the base of the glacials. That the beginning of the *Glossopteris* flora may go back to the beginning of the glacial period, or even slightly precede the latter, has recently been emphasized by Sahni (1939).

UNITY OF PERMIAN ICE-AGE IN AUSTRALIA

It is now a well established fact that the main glaciation of the Southern Hemisphere in the late Paleozoic was preceded by local glaciations in eastern Australia and in Argentine of about middle Carboniferous age. In New South Wales these Carboniferous Kuttung glacials are younger than the marine Burindi series in the basal part of which goniatites of upper Tournaisian age are known to occur (Delépine, 1940). The correlation of the upper Burindi with the Viséan (Carey and Browne, 1938) is thus substantiated, and the middle Carboniferous or Namurian age of the Kuttung glacials seems to be unchallengeable. This was already proposed by Carey in 1938 who also showed that the Kuttung glaciation must have been a process of repeated advances and retreats of the ice, as climatic changes were clearly indicated in the sediments of the Werrie Basin of New South Wales where the Kuttung series can be studied particularly well. *The Kuttung glaciation thus took place at the time of the deposition of the Moscovian series in European Russia and falls in Dunbar's Fusulina zone of the marine sequence of Russia and the United States* (Dunbar, 1940).

In the Hunter River district of New South Wales the Kuttung glacials are conformably overlain by the Lochinvar tillite of the lower Marine. This mode of superposition alone makes it unlikely that a very considerable time elapsed between the deposition of the two series. It has been indicated in a previous paragraph that the Lochinvar glaciation began early in, or perhaps even slightly prior to, Sakmarian time. The interval between the Kuttung glacials and the earli-

est Lochinvar glacials, therefore, corresponds with not more than Dunbar's *Triticites* zone of the marine sequence of the northern hemisphere, or with the Westphalian and perhaps part of the Stephanian of the continental sequence. We know nothing of the history of any part of Australia during this interval and it is not impossible that glacial conditions might have continued, even if this does not appear from the sedimentary record. This possibility has already been indicated by Walkom (1930, p. 167).

The sequence of the following events in Australia has often been pictured as a series of glaciations interrupted by long interglacial stages, extending over a considerable period of time. Thus, Salomon-Calvi, in his excellent summary of the Permo-Carboniferous glaciations (1933, p. 140), speaks of "five, if not six, great glaciations, separated by very long interglacial periods" in Australia, which in Schuchert's opinion were so long (1932, p. 547) that these ice-ages "cannot be regarded as recurrences of cold times spaced in chronogenesis as were those of Pleistocene time."

This extreme view is hardly tenable. *Although the time from the beginning of the Sakmarian to the end of the Artinskian was, presumably, considerably longer than the Pleistocene period, the general course of both glaciations has probably been similar.*

Our previous discussions of the age of the Western Australian deposits and their correlation with strata elsewhere in Australia tend to show that after the first climax of glaciation early in Sakmarian time the climate must have improved gradually during the Sakmarian and the early Artinskian, when glacial sedimentation was gradually restricted to the Kimberley district. There was a general, rather marked, but short interglacial stage in the Artinskian, indicated by the Greta Coal Measures of New South Wales, the Irwin River Coal Measures of Western Australia, and their equivalents elsewhere, and a new glacial stage later in the Artinskian which probably came to a close at the beginning of Kungurian time. This late Artinskian glaciation was much less severe. It is mostly in evidence in the Hunter River district of New South Wales, but at some time or other glacial sedimentation also spread to Western Australia, Queensland, and Tasmania, perhaps indicating one short major stage of the late glacial phase. These might not have been the only variations of climate. The course of events might well have been one of repeated improvements and deteriorations of climate on a minor scale, which we can not yet follow in detail.

Furthermore, we recognize the important fact that the rich warm-water faunas of the Permian Tethys only reached their full development during the later, milder stages of the glaciation in Australia.

Conditions were not as Gerth pictures them in 1926 (p. 13): a rich warm-water fauna populating the Timor geosyncline at the time when the entire Southern Hemisphere was covered by an extensive ice-sheet. Only the Somohole fauna is contemporaneous with the main Sakmarian glaciation. By the time the much richer Artinskian Bitaoeni fauna was introduced into the Timor geosyncline, refrigeration in Australia was much less severe. A marked interglacial period occurred in Australia during part of Bitaeni time and glaciation had ceased in all the other countries that were under ice in Sakmarian time.

WESTERN AUSTRALIA AND "GONDWANALAND"

The interpretation of the late Paleozoic history of Western Australia is of considerable interest in connection with the reconstruction of Gondwanaland. When the idea of Gondwanaland was first clearly conceived by Eduard Suess, it was thought that a great land mass existed in Paleozoic and early Mesozoic time, comprising parts of South America, the greater part of Africa, Peninsular India, and Western and Middle Australia, which were then connected by huge land masses where now the South Atlantic and the Indian Ocean are situated. This idea is best expressed on Haug's paleogeographical map of the "Anthracolithic period" (1911). It was then thought that all these countries were characterized by purely terrestrial (including glacial) deposits of Carboniferous, Permian, and Mesozoic age. On the other hand, four years after the publication of Haug's *Traité*, Wegener published his well known map of the Paleozoic "Pangaea" in which the existence of former land bridges across the Atlantic and Indian oceans was denied (Wegener, 1915). However, by that time marine "Carboniferous" faunas were already known from Western Australia and the existence of a land connection between Australia and India had been seriously questioned by Koken as early as in 1907.

Wegener's ideas of continental drift, in part greatly modified, served as the basis for attempts at paleogeographical maps of Gondwanaland by Argand in 1922, by Brooks in 1926, by Salomon-Calvi in 1933, and by Du Toit in 1937. Among the more conservative reconstructions Schuchert's maps of 1928, 1932, and 1935 must be mentioned. On the later of these maps, the "bridge" between Australia and India has dwindled to a rather insignificant tongue stretching a little more than half way from India toward Australia and occupying a position close to the Malay Peninsula, Sumatra, and Java. On similar lines Willis, in 1932, tried to establish an "East Indian Isthmus," comprising Java, Flores, Timor, and the islands of the outer Banda arc, as well as a number of northern islands of the East Indian Archi-

pelago. Born, in 1932, abandoned the idea of any land connection between India and Australia, although with some hesitation. Also, Case, in 1926, mainly on account of the distribution of Paleozoic tetrapod life, claimed the non-existence of land connection between India and Australia during the Paleozoic. Tillyard and Wade suggested a land connection between the southwest corner of Australia (Cape Leeuwin) and Madagascar (Wade, 1939).

Two facts stand out clearly: the connection of Western Australia with other Gondwana countries must have been sufficiently close to permit the *Glossopteris* flora to spread to Australia but must have been insufficient to provide a migratory route for any large-scale invasion of tetrapod life.

It is now evident that a continuous trough of sedimentation existed along the western margin of the Australian shield from at least early Sakmarian time into Kungurian time. This trough reached southward at least as far as the Irwin River; if it extended still farther south its sediments must now be buried by the Mesozoic and Tertiary sediments of the southwestern coastal plain. There is evidence that the northern part of this trough came into existence in Middle Devonian time. The thickness of beds, in places 10,000 feet of upper Paleozoic rocks alone, in conjunction with the fact that the beds in most places were formed in a short time under shallow-water marine, or estuarine and lacustrine, conditions, indicates considerable crustal mobility, characteristic of geosynclinal belts. In addition to the geosynclinal character of the sedimentation there has been a noticeable tangential movement in this belt. It is not intended to give a detailed picture of the structural history of the region, but it may be mentioned that, in the Kimberley district, Wade noted considerable folding activity during the Devonian which continued during the Carboniferous and Permian. In the North-West post-Permian folding is evident which has probably also affected the Irwin River area. Further folding in the North-West took place in late Tertiary, probably Pliocene, time when the Cretaceous and Tertiary sediments were thrown into a series of gentle anticlines and synclines, trending approximately north and south.

After consideration of all these facts, *it becomes evident that the present western margin of the Australian pre-Cambrian platform is a very old line of demarcation.* During the Mesozoic and Tertiary the area of the Westralian geosyncline was subjected to numerous marine transgressions and, in spite of many gaps in the sequence, it provides the most complete marine record of these times anywhere in Australia (Teichert, 1939c). This trough is continuous with the Timor-East

Celebes geosyncline of the East Indies the history of which has recently been described by Umbgrove (1938). This continuous trough has received sediments from the Australia-New Guinea shield, in some parts since the middle Paleozoic, in others since upper Paleozoic and throughout Mesozoic and Tertiary time.

These facts are a serious objection to any East Indian isthmus connections between Australia and Asia, quite apart from the fact that such an isthmus in the sense of Willis is disproved by at least one of the features which it obviously wants to explain: the arrival of the *Glossopteris* flora in Australia. An East India isthmus would have brought the Sumatran *Gigantopteris* flora, not the Indian *Glossopteris* flora, to this continent. This *Gigantopteris* flora, which was described in detail by Jongmans and Gothan in 1935, is found in beds overlying the marine Telok Gedang strata which contain fusulinids of definitely Sakmarian age (see Thompson, 1936a), and must, therefore, be of late Sakmarian or, more likely, of early Artinskian age.[7] At this time the *Glossopteris* flora was already established in Australia. It should in this connection be mentioned that Kuenen, in his geological analysis of the bathymetric conditions of the East Indies (1935), found no evidence to support the assumption of former east-west land bridges or isthmuses in this region.

In order to explain the existence of the *Glossopteris* flora in Australia it is, however, not necessary to assume the existence of any direct land connections between Western Australia and any land at the west. The whole problem of the distribution of this flora has been somewhat simplified since Virkki's discovery of winged "pollen-grains" of *Glossopteris* in the basal tillite series of India and Australia (1937, 1939). The dispersion of such spores would not have been prevented by the Westralian-Timor-East Celebes trough but, on the other hand, even spores would have found it difficult to bridge a gap of the size of that between India or any of the other Gondwana countries and Western Australia of the present day. Also, the fact that many species of the Gondwana floras of India and Australia are identical, makes it necessary to assume that free exchange of spores between the two regions was possible.

The problem thus remains that, while Australia undoubtedly was separated from the other Gondwana countries at least since the beginning of the Sakmarian glaciation, it can hardly have had a geographical position as isolated as that of the present day. There must have been fragments of "Gondwanaland" closer to Australia than either India or Madagascar at the present time. However, it is not

[7] For stratigraphic relations, compare Zwierzycki, 1935.

proposed to enter the speculative field in this article and the writer concludes by pointing out a few indisputable facts which emerge from the stratigraphical study of Western Australia.

1. The geographical connections between Australia and the eastern part of the East Indian Archipelago date back at least to the later part of the Paleozoic. The relative geographical position of these two regions since that time must have been more or less the same as now.

2. Attempts at a reconstruction of Gondwanaland in which Western Australia is placed alongside Peninsular India can be dismissed. Umbgrove (1937) has already drawn attention to important differences in the geological structure of the corresponding coasts of India and Australia and these differences are now even more obvious. The closest similarities between strata on the east coast of India and on the west coast of Australia are observed in late Cretaceous (Maestrichtian) time when an almost identical ammonite fauna is found in beds of corresponding age (Valydayur group of Trichinopoly district and upper Cardabia series of Western Australia (Spath, 1940).

3. No evidence is found in Western Australia to support either Du Toit's supposed "northerly creep" of Australia in Tertiary time or Kuenen's "anti-clockwise rotation" of this continent.

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SOME PROBLEMS OF APPALACHIAN STRUCTURE[1]

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ABSTRACT

The Appalachian foreland lies north and west of a closely folded and faulted mountain zone. The search for oil and gas production from deeper formations has emphasized the importance of an understanding of the structure of this area. This structure is much more complex than was formerly supposed. That the stresses active in forming the foreland folds and faults represent principally the diminishing activity of the deforming thrusts of the associated mountains is the usual assumption, but little is known of the mode of transmission and application of these stresses.

The origin of the structures, the effects of rotational stresses, the dates of deformation, and the shape and downward change in position and intensity of the folds are discussed from the standpoint of problems which have received insufficient attention and on which more data are needed. It is thought that an appreciation of these problems and of the general structural complexity of the area may result in a search for, and analysis of, data that will lead to their solution.

INTRODUCTION

The search for oil and gas production from deeper formations in the Appalachian province has emphasized the importance of a better understanding of the structure of this area. Most of the old shallow oil and gas pools of Pennsylvania and adjoining states are of the stratigraphic type. They are "sand-condition" pools, and a knowledge of the structure would have been of little assistance in discovering them. In contrast to this most of the Oriskany pools and, assumably, those from deeper formations are of the structural type. Accumulation is modified by sand conditions, but a consideration of structure is fundamental to their discovery.

Two structural zones have long been recognized in the Appalachians—a closely folded and faulted belt on the southeast and a bordering zone of diminishing intensity of deformation on the northwest. This bordering zone of mild deformation is the Appalachian foreland. The northern part of this foreland—extending from central West Virginia across Pennsylvania and into New York—is the area under consideration in this paper.

The structures of this area are deceptive in that they are much more complex than at first appears. It is not the purpose of this paper to advance any particular theories regarding these structures, but it is intended to emphasize the fact that they are more complex than was formerly supposed and to indicate a few of the problems involved.

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Before discussing these problems, however, it may be well briefly to describe the structures under consideration.

DESCRIPTION OF STRUCTURES

The Appalachian foreland is a broad, gentle, spoon-shaped synclinorium the lowest part of which is in northern West Virginia. It is sharply delimited from the more intensely deformed zone by the Appalachian structural front.

It is characterized by long and locally sinuous folds which are approximately parallel with the structural front and with the axis of the synclinorium (Fig. 1). These folds rise and plunge in domes and saddles along their trend. They appear as gentle undulations of progressively decreasing magnitude away from the structural front. Locally they offset in *en échelon* pattern and the sinuous trends may represent such offsetting at depth. As the folds decrease in magnitude they become more irregular in trend and in the northwestern part of the foreland they are very low and sinuous. In this outer part of the area north-south trends are locally well developed. This north-south influence may also be present in the more strongly folded area but is not clearly defined there.

It was formerly supposed that these folds, like the steeper structures southeast of the Appalachian front, are asymmetrical toward the northwest and migrate, with depth, toward the southeast. The apparent asymmetry of gentle folds is deceptive, however, because the effect of regional tilting is in the dips as mapped. When correction is made for this tilting, it is found that the folds here are basically asymmetrical toward the southeast. The anticlines are on the average about 1.3 times steeper on the flanks facing the more intensely deformed mountains than on the outer flanks. The degree of asymmetry does not vary with the intensity of the fold or with distance from the structural front.

As nearly as can be determined from the data now available the anticlines increase in intensity with depth and migrate away from the structural front.

Surface faults of small displacement and local areas of abnormally steep dips are common but easily overlooked in the mapping. Drilling has supplied evidence of extensive faulting in the deeper formations. High-angle reverse faults dipping away from the structural front appear to be the most common type in the Oriskany. With one questionable exception, these faults are, so far as known to the writer, limited to the southeastern flanks of the anticlines.

Another feature pertinent to the consideration of these structures

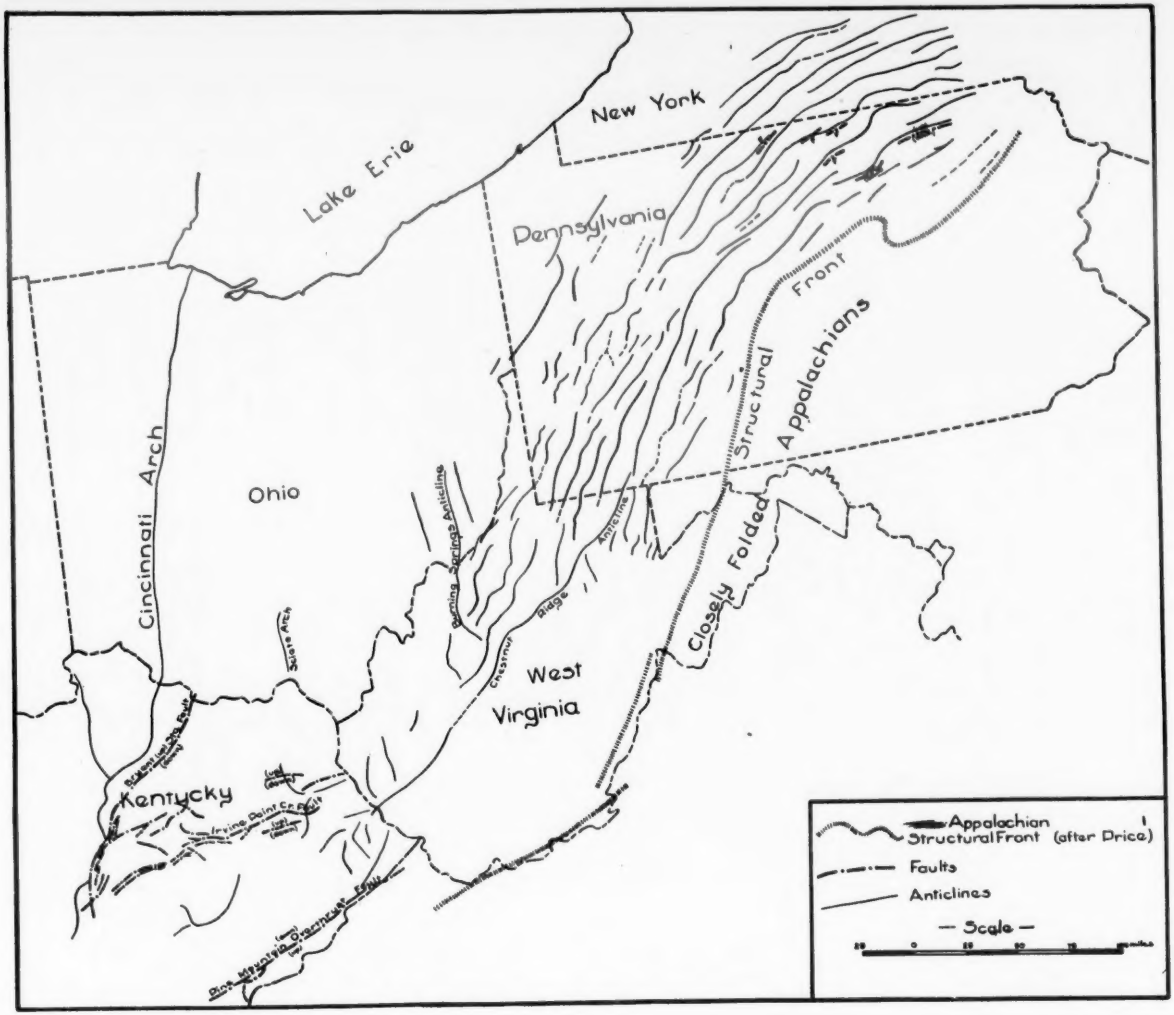
New York
Lake Erie
Pennsylvania
Cincinnati Arch
Ohio
Structural Front
Appalachians
Closely Folded
Kentucky
West Virginia
Appalachian Structural Front (after Price)
Faults
Anticlines
— Scale —

FIG. 1

is the well known fact that they correspond in position with a wedge-like thinning-out of sediments away from the deepest parts of the geosyncline. The sedimentary section extending from the lower Silurian to the lower Pennsylvanian thins northwest at a rate of 60–80 feet per mile. From this fact it is concluded that late in the Paleozoic the deep Cambro-Ordovician limestones and basement complex had a southeastward regional dip of at least 60 feet per mile.

DIRECTION OF STRESSES IN FORELAND

Willis,[3] in his classic studies on the mechanics of Appalachian structure, concluded that tangential stresses from the southeast were transmitted through competent Cambro-Ordovician limestones to form the overturned folds and reverse faults which characterize the intensely deformed zone. It is generally assumed that this thrust toward the northwest continued, with diminishing intensity, across the foreland and raised folds of progressively decreasing magnitude.

In contrast to the concept of a northwest thrust are the gliding theories of Haarman[4] and Bain.[5] According to these theories the active movement in the foreland was flowage of the sediments down the slope of the basement complex. Although not subscribing to these flowage theories, Chamberlin[6] also considers the possibility that the stresses in the foreland were directed toward the mountains, and southeastward movement here is in keeping with the compressive phase of crustal deformation as considered by Bucher.[7]

Neither the northwestward diminution in the intensity of deformation nor the southeastward asymmetry of the folds supplies satisfactory evidence on this problem. The northwestward decrease in folding is the expectable result of either a thrust from the southeast or of flowage of the sediments down the slope of the basement complex or of movement in the basement toward the deepest part of the geosyncline. The slightly steeper southeast flanks of the folds, the downward crestal migration north and west, and high-angle reverse faults dipping away from the structural front are thought to be the results

[3] Bailey Willis, "Mechanics of Appalachian Structure," *U. S. Geol. Survey 13th Ann. Rept.*, Pt. 2 (1892), pp. 213–81.

[4] E. Haarman, *Die Oazillationstheorie, eine Erklärung der Krustenbewegungen von Erde und Mond.* Stuttgart (1930).

[5] G. W. Bain, "Flowage Folding," *Amer. Jour. Sci.*, Vol. 22, Ser. 5 (1931), pp. 503–30.

[6] Rollin T. Chamberlin, "Isostasy from the Geological Point of View," *Jour. Geol.*, Vol. 39 (1931), pp. 19–22.

[7] Walter H. Bucher, *The Deformation of the Earth's Crust.* Princeton University Press (1933).

FIG. 1

of the wedge-like form of the sediments and bear no necessary relation to the direction of the deforming stresses.[8]

Perhaps evidence bearing on this problem will be found in the comparatively unmapped outer part of the foreland. Active southeastward movement—especially sediment flowage—should have left extensive tension fractures and faults in Ohio and northwestern Pennsylvania.

MECHANICS OF FOLDING

If the usual assumptions that this area was deformed by a thrust from the southeast and that this thrust was transmitted through the deep Cambro-Ordovician limestones and the basement complex are correct, we are still left with the problem of the mechanics of the folding.

The tangential stresses as calculated for the limbs of arches of the folds under consideration so greatly exceed the crushing strength of the materials involved as to lead to the conclusion that they must always have been supported from below. For example, Ashley[9] calculated a stress of about 1,000 times the crushing strength of the materials for the flanks of the Chestnut Ridge anticline near Punxsutawney, Pennsylvania.

Perhaps this necessary support came through basement flowage resulting from the general shortening of the area. Such flowage into the growing anticlines may have been the dominant raising force and the rôle of the "competent" beds have been primarily that of shaping the fold. Flowage through an isostatic type of adjustment, from below the synclines into the anticlines, may have been an accessory factor in raising the latter. In this connection it is noteworthy that profiles of the structures as they appear at the surface indicate, by the general uniformity of a syncline-to-syncline surface as compared with the irregular heights of the anticlines, that rise of the anticlines was the dominant movement in the deformation. These profiles also indicate, however, that sinking of the synclines did occur locally.

Information on the amount of relief in the basement and the location of this relief with respect to the surface folds would go far toward clarifying our concept of the mechanics of the folding and of the deep tectonics of this area.

[8] R. E. Sherrill, "Symmetry of Northern Appalachian Foreland Folds," *Jour. Geol.*, Vol. 42 (1934), pp. 225–47.

[9] George H. Ashley, "Studies in Mechanics of Allegheny Structure," *Science*, N. S., Vol. 27 (1908), pp. 924–25.

ROTATIONAL STRESSES

That rotational stresses must be considered in analyzing the deformation of this area is indicated by the arcuate form of the folds of both the foreland and the more intensely deformed zone on the southeast. This is also indicated by the varying intensity of folding in different parts of the foreland.

As an example of this, the foreland seems to have been thrust farther northwest in southern than in central Pennsylvania—if it is assumed that the active movement was away from the structural front. The individual folds decrease in intensity from southern to central Pennsylvania and increase into northern Pennsylvania. The total surface shortening involved in the folding is about 1,000 feet in southern Pennsylvania and only about 50 feet in central Pennsylvania.

The rotational effect incident to this difference in shortening may have been too slight to have caused any significant results. It may, on the other hand, have resulted in easier relief parallel with the folds than vertically. In the latter event vertical, or steeply inclined, north-south and east-west shear zones may be present at or below the surface. Such speculation might be carried further to include a hypothetical explanation of the *en échelon* offsetting, and the north-south alignment of domes and high points in synclines noted in parts of the area. It is a problem which has received little attention.

The divergence in trend between the Cincinnati arch and the Appalachian folds has often been noted in the literature. An assumed northwest thrust in the foreland would, if continued to the north-south trending arch, meet it at an angle of about 65°. If the Cincinnati arch acted as a buttress, the compressional component perpendicular to it might explain the north-trending folds in the outer part of the foreland. If rotational movement parallel with the arch occurred, that is, if movement in the basement was deflected northward by the arch, north-trending shear zones, northwest tension fractures, and northeast-striking folds would be expected in Ohio and northwestern Pennsylvania. Isolated examples of all these structures have been reported or have been observed by the writer but sufficient data to determine that they are characteristic of this part of the foreland have not been assembled.

DATE OF FOLDING

The date of the deformation of the Appalachian foreland is another problem on which additional data are needed.

The youngest folded beds are Permian and it is rather generally assumed that the entire deformation here occurred during the Appalachian revolution at the close of the Paleozoic. Although this is probably correct in so far as these youngest beds are concerned there is evidence that the older formations were gently folded periodically during the Paleozoic.

One evidence suggestive of recurrent folding here is the presence of regional disconformities at several places in the section—notably at the base of the Pennsylvanian and in the lower part of the Devonian. It does not seem probable that the strata passed through these periods of oscillation, tilting, and erosion without some folding.

It is also noteworthy that steep dips and intricate folding and faulting appear to be characteristic of the Devonian shales where exposed in the water-gaps through anticlinal ridges. All such exposures which have been observed by the writer are immediately overlain by talus or other cover which precludes the possibility of definitely dating the folding.

The more intensely deformed zone bordering the foreland is known to have been periodically deformed during the Paleozoic. Ashley[10] has concluded "that each thick sandstone was the result of mountain making forces that acted on the shoreward edge of the rocks just laid down and folded and lifted them into mountains."

The downward increase in the intensity of folding and the presence of faults which decrease or disappear upward are strongly suggestive of recurrent folding, but may be explained by adjustment in the thick Devonian shales. Whether or not the rate of downward increase is accentuated at the disconformities is not known.

The general uniformity in the rate of thickening of the Devonian has been suggested as evidence that no significant folding occurred during or at the end of that period. The wells on which this is based are generally located on anticlines and are widely scattered. They do not satisfactorily demonstrate absence of thickening into the synclines.

CONCLUSION

In conclusion, it may be well to repeat that the primary objectives of this paper have been to emphasize the structural complexity of the Appalachian foreland and to mention some of the problems involved. The origin of the folds—including the direction of stress and the mechanics of the folding—the effects of rotational stresses, and the date of the folding, were the problems selected for brief consideration.

[10] George H. Ashley, "Old Mountain Theories Are Challenged by New Findings," *Bull. Pennsylvania Dept. Internal Affairs* (December, 1939).

These problems can not properly be limited to the foreland. They are parts of our entire concept of mountain deformation. The foreland problems have, however, received scant attention in the numerous theories of orogeny.

Further geophysical, well-record, and general stratigraphic data are clearly needed in working toward a solution of these problems. Also important are the accumulation, correlation, and interpretation of data on the joints, local faults, and areas of exceptionally steep surface dips. It is also clearly necessary that each structure and each problem be considered as part of a large regional picture into which it must fit.

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GEOLOGICAL NOTES

NEWMAN SALT DOME, WARREN COUNTY, MISSISSIPPI[1]

JOSEPH NEELY[2]
Jackson, Mississippi

Mississippi's fifth shallow salt dome was discovered by the drilling of the Magnolia Petroleum Company's Brown-Paxton No. 1, in Sec. 12, T. 14 N., R. 4 E., Warren County, Mississippi. This test, located as the result of geophysical work, was abandoned as a dry hole on November 23, 1940, after penetrating 293 feet into salt. After drilling 1,620 feet into the Wilcox section, dolomitic sand was encountered at a depth of 4,935 feet, followed by porous broken dolomitic limestone at 5,055 feet, anhydrite cap rock at 5,086 feet, and finally salt at 5,108 feet. The name which is used to designate this salt dome was taken from the town of Newman, located in the vicinity of the test.

[1] Manuscript received, January 29, 1941.

[2] Magnolia Petroleum Company.

TATUM SALT DOME, LAMAR COUNTY, MISSISSIPPI[1]

CECIL L. MORGAN[2]
Jackson, Mississippi

The Tatum Lumber Company's W. S. F. Tatum No. 1, in Sec. 14, T. 2 N., R. 16 W., Lamar County, Mississippi, encountered salt at 1,516 feet. This test proved the fourth interior shallow salt dome in the state of Mississippi.

W. S. F. Tatum, president of the Tatum Lumber Company, planned a test at this location because he had noted a peculiar drainage pattern surrounding an area in which pine seedlings would die after reaching a height of 2 or 3 feet. A seismograph survey of the area was made in 1940 and a location was recommended which coincided with the location which Tatum had planned to drill.

This well was abandoned as dry on October 21, 1940, at a total depth of 2,077 feet, after penetrating 561 feet of salt. Circulation was lost at 939 feet and again at 1,092 feet. The anhydrite cap rock was encountered at 1,096 feet, near the base of the Catahoula formation.

[1] Manuscript received, January 29, 1941.

[2] Consulting geologist, 121 Sumner Street.

SILURIAN PRODUCTION, SHIPLEY FIELD, WARD COUNTY, TEXAS[1]

C. D. CORDRY[2] AND M. E. UPSON[2]
Fort Worth, Texas

The development of production from the 7,000-foot level in a white limestone of Silurian age in the Shipley area of southeastern Ward County, Texas, represents the first commercial production found in the state from beds of this age.

The Gulf Oil Corporation's Wristen Brothers No. 5, located 2,332 feet from the northwest line and 2,322 feet from the southwest line of Sec. 18, Block 5, H. & T. C. R. R. Company Survey, Ward County, Texas, was completed on December 13, 1940, in a pay zone between 7,010 and 7,060 feet, after having been drilled to a total depth of 9,187 feet and plugged back to 7,075 feet. Seven-inch casing was cemented at 6,968 feet, and after being acidized and thoroughly washed the well flowed 1,595 barrels of oil during a period of 12 hours. The gravity of the oil was 32° Bé.

The area in which this deep test is located has been producing oil from sandstone beds of the Whitehorse group for approximately 10 years, and numerous wells have been completed. The local structure contoured on the Yates sandstone shows a pronounced east-west trending nose, this well being located on the crest of the feature. Regionally, this structural feature occupies a position on the west flank of a series of large structures extending from north-central Pecos County northward into west-central Crane County.

The Wristen Brothers No. 5 test penetrated a normal sequence of Triassic redbeds, Dewey Lake redbeds, Rustler formation, Salado and Tansill formations, and encountered the top of Yates sandstone at a depth of 1,825 feet. The base of the Whitehorse group was encountered at approximately 2,900 feet. From 2,900 to 6,330 feet a succession of dolomite and limestone beds of Permian age was penetrated. The lowermost 40 feet of this interval is conglomeratic and slightly shaly.

Sedimentary rocks of Devonian age were penetrated from 6,330 to 6,930 feet. This interval is readily divisible into three units: the upper from 6,330 to 6,550 feet, consisting of light gray to tan chert and very siliceous limestone; the middle from 6,550 to 6,750 feet is a predominantly brown chert and siliceous limestone, the lower 90 feet containing thin beds of dark gray shale; and the basal unit extending

[1] Manuscript received, January 29, 1941.

[2] Gulf Oil Corporation.

from 6,750 to 6,930 feet consists mainly of gray shale, some black shale, and dense buff to dove gray limestone with a 5-foot bed of maroon shale at the base. Small resinous spores are abundant in the black shale.

The interval from 6,330 to 6,930 feet is correlated with the lower part of a section present between 10,167 and 11,153 feet in the Gulf Oil Corporation's J. T. McElroy No. 103, located in the McElroy field in western Upton County, approximately 32 miles farther east.

Approximately 600 feet of the formation encountered in the McElroy well has been removed by erosion where this test was drilled. However, the three lithologic units can be readily correlated with the lowermost part of the section present in the McElroy test. This correlation is based on certain lithologic characteristics exhibited by the cuttings and the insoluble residues. The top of the middle, or brown cherty unit, encountered in the Wristen test at 6,550 feet, was found in the McElroy test at 10,982 feet. The lowermost, or shaly unit, is almost entirely missing in the McElroy test.

No fossil evidence other than the presence of spores was found in the cuttings from the Wristen test. However, the upper, or the fossil-bearing, part of the section encountered in the McElroy test is absent in this test due to erosion. The upper part in the McElroy test is fossiliferous, the fauna consisting of brachiopods, crinoids, trilobites, bryozoans, and ostracods. The bryozoans and trilobites have been identified as Silurian or Devonian in age. The following ostracods have been identified: *Thlipsura* cf. *furca*, *Bollia* sp., and *Phanassymetria* sp. *Thlipsura* cf. *furca* and *Phanassymetria* sp. occur in abundance in the Haragan formation of Devonian age which crops out in the Arbuckle Mountains of Oklahoma. This section under discussion is also believed to be a partial equivalent of the Caballos chert and novaculite exposed in the Marathon area of West Texas.

From 6,930 to 7,110 feet in the Wristen test a white and slightly pinkish, coarsely crystalline limestone was encountered which can readily be divided into three lithologic units, namely: an upper white, coarsely crystalline, crinoidal limestone; a middle glauconitic limestone and shale; and a lower oölitic limestone. This limestone, with the aforedescribed units, can be correlated with an almost identical section in the McElroy test occurring between 11,153 and 11,346 feet. No diagnostic fossil evidence has been found in this section in either test, but due to the fact that it occurs between beds of definite Devonian and Ordovician age, and also because it has certain lithologic characteristics common to the Fusselman limestone of the trans-Pecos

region of Texas and the Chimneyhill limestone of the Arbuckle Mountains of Oklahoma, it is believed to be Silurian in age.

The oil-bearing zone, occurring from 7,010 to 7,060 feet, was cored from 7,020 to 7,058 feet but recovery was very poor. The porosity probably is cavernous in type. The limestone is nearly pure, with practically no residue remaining after treatment with hydrochloric acid.

From 7,110 to 7,375 feet a dark brown, slightly cherty limestone of Upper Ordovician age was penetrated. The rare brachiopod fauna present in this section has not been completely identified but possesses certain Ordovician characteristics. This section is also present in the McElroy test and in other tests where it has been preserved from erosion. It is lithologically similar to the Montoya and Maravillas formations of the outcrop with which it is correlated.

Middle Ordovician, or Simpson sediments, were penetrated in this test between 7,375 and 9,002 feet and consist of alternating beds of limestone, shale, and sandstone. This thickness of 1,627 feet is one of the thickest yet penetrated in West Texas. It compares with 881 feet in the McElroy test, with which it is similar both faunally and lithologically. Nearly 900 feet of this section was cored to obtain accurate and detailed information on the character of the several sandy zones which were present. Four rather well defined sandstone zones were encountered, all of which were tightly cemented and some of which were shaly. Several disappointing drill-stem tests were taken in the better developed sand zones. These sandy zones are known to be persistent laterally and also known to vary in character within short distances, and equivalent sandy zones in both the uppermost and lowermost Simpson are known to be productive in near-by areas.

Lower Ordovician (Ellenburger) dolomite was encountered at 9,002 feet and drilled to a total depth of 9,187 feet. Fractured and porous dolomite and some oil stains were present. While taking a drill-stem test of the formation at the total depth the packer stuck and the drill stem parted. After numerous unsuccessful attempts were made to clean the hole it was decided to plug back and test upper showings of oil noted when drilling.

COLEMAN POOL DISCOVERY, ARCHER COUNTY, TEXAS[1]

WARD C. BEAN[2]
Wichita Falls, Texas

The Shell Oil Company's W. M. Coleman No. A-1, discovery well of the Coleman field, is 330 feet from the north line and 990 feet from the east line of Lot 3, Block 74, American Tribune New Colony Subdivision, east-central Archer County, Texas. The anticline on which this well is located was discovered by means of seismograph exploration, supported by subsurface data on shallow key beds.

The surface elevation of the Coleman discovery is 963 feet and the surface rocks at the location are lower Permian in age. Strata of Permian and Pennsylvanian age were penetrated to a depth of 5,240 feet, black shales of probable Barnett age were drilled from 5,240 to 5,274 feet, and Mississippian limestone was penetrated from 5,274 to 5,467 feet. Circulation was lost at 5,467 feet and it is believed that the drilling tools encountered a crevice or cavern at that depth; total depth reached by the drill was 5,471 feet.

Casing was set at 5,458 feet to ascertain the fluid content of the fissured limestone at the bottom of the hole. When the cement plug was drilled, the well flowed salt water at an estimated rate of 200 barrels per hour.

The well was then plugged back and casing perforated opposite the upper part of the Mississippian limestone but no fluid was obtained at this level. The "Caddo" limestone, which had been reached at a depth of 5,009 feet, was then perforated and treated with 2,000 gallons of acid. The well responded with an initial flow of 255 barrels of 43° gravity oil in 3 hours on October 17, 1940. The well also yielded gas at the rate of 1,717,000 cubic feet per day.

Strawn sands at 3,648–3,659 and 3,682–3,697 feet yielded 150 feet of oil and 500 feet of oil-cut mud in 15 minutes on a drill-stem test, indicating a second probable production zone for the field.

Prior to the drilling of the Shell Oil Company's Coleman A-1, several shallow dry holes had been drilled in the vicinity. The deepest of these was the Humble Oil and Refining Company's Coleman No. 1, located about 1,200 feet southeast of the discovery and abandoned at a total depth of 2,300 feet.

Two wells drilled subsequent to the discovery have given some indication of the potentialities of this new field. The Southern Petroleum

[1] Manuscript received, February 9, 1941.

[2] Shell Oil Company, Inc.

Exploration Company's Wilson No. A-1, located 3,000 feet west of the Coleman discovery, encountered the "Caddo" limestone 137 feet structurally lower than in the discovery well but had an initial production of 130 barrels per day from that formation after acidization. The Shell's Coleman No. B-1, located 1,000 feet northeast of the discovery well, found the "Caddo" limestone 37 feet structurally higher than in the discovery well. After treatment with 3,000 gallons of acid, this well flowed 625 barrels of oil in 8 hours with an estimated 5 million cubic feet of gas per day.

PERMIAN CORRELATION MEETING, CENTENNIAL, WYOMING, SEPTEMBER 2, 1940[1]

RONALD K. DEFORD[2]
Midland, Texas

The Fourteenth Annual Field Conference of the Kansas Geological Society ended Sunday night, September 1, 1940, near Centennial, Wyoming, high on the eastern slope of the Medicine Bow Mountains. Here, 10,000 feet above sea-level, the conferees spent the night as guests of the University of Wyoming's Science Camp. On Monday morning, about 35 geologists[3] took part in a meeting to discuss prob-

[1] Manuscript received, February 8, 1941.

[2] Argo Oil Corporation. Editor, Permian volume.

[3] List of those who registered: Norval Ballard, with A. I. Levorsen, Tulsa, Oklahoma; Walter R. Berger, consulting, Fort Worth, Texas; Howard S. Bryant, Skelly Oil Company, Tulsa; Arnold S. Bunte, with H. A. Heller, Tulsa; R. A. Carmody, Gulf Oil Corporation, Wichita, Kansas; N. D. Clark, Transwestern Oil Company, Wichita; Virgil B. Cole, Gulf Oil Corporation, Wichita; F. B. Conselman, Gulf Oil Corporation, Wichita; Ronald K. DeFord, Argo Oil Corporation, Midland, Texas; Harold W. Ervin, U. S. Geological Survey, Washington, D. C.; R. V. Ewing, Continental Oil Company, Ponca City, Oklahoma; Alfred Fischer, University of Wisconsin, Madison, Wisconsin; Anthony Folger, Gulf Oil Corporation, Wichita; J. P. Gries, South Dakota School of Mines, Rapid City, South Dakota; R. M. Hansen, Halliburton Oil Well Cementing Company; John W. Harrison, Argo Oil Corporation, Seagraves, Texas; W. C. Imbt, Stanolind Oil and Gas Company, Wichita; C. T. Jones, Stanolind Oil and Gas Company, Wichita; W. J. Kivi, Wyoming Geological Survey, Laramie, Wyoming; Edward A. Koester, Darby Petroleum Corporation, Wichita; Marvin Lee, consulting, Wichita; T. J. Newbill, San Francisco, California; Harry W. Oborne, consulting, Colorado Springs, Colorado; Charles M. Rath, consulting, Denver, Colorado; Charles B. Read, U. S. Geological Survey, Washington, D. C.; H. B. Renfro, University of Wisconsin, Madison, Wisconsin; Ray L. Six, Oklahoma A. & M. College, Stillwater, Oklahoma; H. D. Thomas, University of Wyoming, Laramie, Wyoming; Warren O. Thompson, University of Colorado, Boulder, Colorado; Jerry E. Upp, Amerada Petroleum Corporation, Tulsa; John S. Van Sant, J. M. Huber Corporation, Borger, Texas; Glen C. Wooley, Transwestern Oil Corporation, Wichita; E. A. Wyman, Amerada Petroleum Corporation, Tulsa.

lems of Permian correlation between the Rocky Mountains and the Mid-Continent—more particularly, in the region of Wyoming, the Black Hills, and Nebraska, and Kansas. In the following paragraphs is a brief account of the origin of this correlation meeting.

PREPARATION FOR MEETING

About a year previously, when the regional stratigraphic committees for work on the Permian volume were being formed, Anthony Folger had championed the necessity of simultaneous work on the problems of interregional correlation. This idea was discussed, but no action was taken until the Chicago convention, where a "Permian breakfast" in the Stevens Hotel was attended by many geologists at work on, or interested in, the Permian. This "breakfast" lasted almost throughout the morning of Monday, April 10, 1940. One of the things accomplished was to elect Anthony Folger "tool-pusher" or director to see that subsurface geologists actively studying the problems of correlations between the northern Rockies and the Mid-Continent should examine the same sets of cuttings from critical wells. Once all these geologists were familiar with the same fundamental data, they could discuss and argue about their differences as to proper correlations in concrete terms. They would speak the same language.

It was planned to hold a correlation meeting during the Kansas society's 1940 field conference. Folger agreed to try also to have several cross sections prepared by different geologists for this meeting.

The time was short. A number of samples were looked at, but many more remain. Three cross sections were prepared.

1. *C. T. Jones.*[4]—This cross section begins in southwestern Ellis County, Kansas; extends northward through Norton County, Kansas; thence northwestward through western Nebraska; thence more or less westward through Niobrara County, Wyoming, to the Big Muddy field in Converse County, eastern Wyoming.

2. *R. A. Carmody.*[5]—This cross section begins in the Gorham field, southwestern Russell County, Kansas; extends northwestward through Ellis, Rooks, Graham, and Norton counties, Kansas; and continues northwestward into Nebraska almost to the northwest corner of the state.

The important difference between the cross sections of Jones and Carmody is that Jones' section in general passes through structurally

[4] C. T. Jones, "Subsurface Section from Big Muddy Field, Converse County, Wyoming, through Nebraska, to Central Kansas Uplift, Ellis County, Kansas," *Guide Book 14th Ann. Field Conference Kansas Geol. Soc.* (1940), pp. 140–41.

[5] Not published.

high wells, whereas Carmody's section in general passes through structurally low wells.

3. Norval Ballard.[6]—The exact location of this section is not available, but in general it follows closely the route of Carmody's cross section to the northwest corner of the state of Nebraska and extends thence on up into the Black Hills of South Dakota.

At the Centennial correlation meeting Jones' cross section was available in the guide book, and Carmody's and Ballard's cross sections were hung on the wall. Several adjuvant cross sections[7] were also printed in the guide book.

BLACK HILLS–WYOMING CORRELATIONS

A spirited discussion occupied the morning. Jones, Ballard, and Carmody each presented his cross section, and alternative hypotheses of gradation, overlap, and correlation were suggested and discussed by others present. This note is an attempt to summarize the discussion in terms of the section exposed on the northeast flank of the Black Hills in South Dakota.

	Feet
Spearfish redbeds	300–500
Minnekahta limestone[8]	40
Opeche red shale	85
Minnelusa sandstone and limestone	500

At present the Minnekahta limestone[8] appears to be the surest key-bed in regional correlations of the Permian formations and their subjacent Pennsylvanian and superjacent Triassic beds. The upper-

[6] Not published.

[7] H. D. Thomas, "Cross Section from Wind River Mountains, Fremont County, Wyoming, to Agate, Sioux County, Nebraska," Pl. VIII, p. 120.

———, "Cross Section from Red Mountain, Albany County, Wyoming, to Minnekahta Region, Fall River County, South Dakota," Pl. IX, p. 123.

G. E. Condra and E. C. Reed, "Correlation Chart of Minnekahta, Opeche, Hartville, and Minnelusa Formations in Hartville and Black Hills Uplifts," Pl. X, p. 126.

C. T. Jones, "Cross Section from Nesson Anticline, Williams County, North Dakota, through Baker-Glendive to Northern Black Hills, Lawrence County, South Dakota," Pl. XI, p. 130.

W. O. Thompson and J. M. Kirby, "Relationship of Permo-Pennsylvanian Stratigraphic Units between Colorado Springs, Colorado, and the Black Hills, South Dakota," Pl. XIII, p. 143.

———, "Colorado Front Range Sections," Pl. XIV, p. 144.

———, "Southeastern Wyoming Sections," Pl. XV, p. 145.

———, "Black Hills Sections, Wyoming and South Dakota," Pl. XVI, p. 146.

John G. Bartram and C. T. Jones, "Stratigraphic Cross Section from Belle Springs, Carbon County, Wyoming, to South End of Black Hills, South Dakota," Pl. XVII, p. 147.

E. W. Krampert, "Correlations of Well Sections in the Paleozoic Formations, Dewey Dome, Mule Creek, and Lance Creek Fields," Pl. XXI, p. 157.

[8] Called "dolomite and lime" in *Guide Book*, Fig. 2, p. 20. In this note the term "limestone" includes all the magnesian and non-magnesian varieties.

most member of the Opeche immediately beneath the Minnekahta limestone is purple or lavender shale, which persists for hundreds of miles.

In the vicinity of Casper, Wyoming, the relation of the Minnekahta to the overlying Forelle and Ervay limestone members seems well established. Thomas[9] has shown that the Ervay limestone is an eastward-extending tongue of the topmost Phosphoria formation of western Wyoming. Thus the Ervay represents the youngest Permian of the region. The age relations according to Thomas are the following.

West	*East*
Dinwoody (?)	Little Medicine tongue
Topmost Phosphoria	Ervay limestone
Middle Phosphoria	Forelle limestone
Lower (but not lowermost) Phosphoria	Minnekahta limestone

Thus, in the Casper region, the redbeds above the Minnekahta are partly Permian and partly Triassic in age (150–250 feet of Permian; 600–700 feet of Triassic).

At the north end of the Black Hills above the Minnekahta are 300–500 feet of Spearfish redbeds. It is generally agreed that at least the lower part of these is Permian. Some geologists think it possible that the Spearfish there is all Permian. Some suspect a Triassic upper part, above the gypsums, marked by a lithologic change (coarse sand grains of more heterogeneous shapes and sizes, for example).

Below the Minnekahta another problem of correlation presents itself. *The typical Opeche of the northeastern flank of the Black Hills consists of 60–85 feet of red shale.* Underlying the Opeche is the Minnelusa formation in which sandstones predominate,[10] especially in the upper part, though limestone members are numerous throughout and thicker in the lower part of the formation. Red shales are present in some exposures.

In the outcrop in Hot Brook Canyon,[11] near Hot Springs, South Dakota, at the southern end of the Black Hills, the so-called "Opeche" is 154 feet thick. Its base is assumed to be at the top of a brecciated limestone member of the Minnelusa. The "Opeche" here consists of the following.

	Feet
Red sandy shale	61
Red blocky sandstone	93

The red blocky sandstone contains red sandy shales and is underlain by brecciated limestone members of the Minnelusa.

[9] H. D. Thomas, *op. cit.*

[10] *Guide Book*, Fig. 2, p. 20.

[11] *Guide Book*, Fig. 15, p. 34.

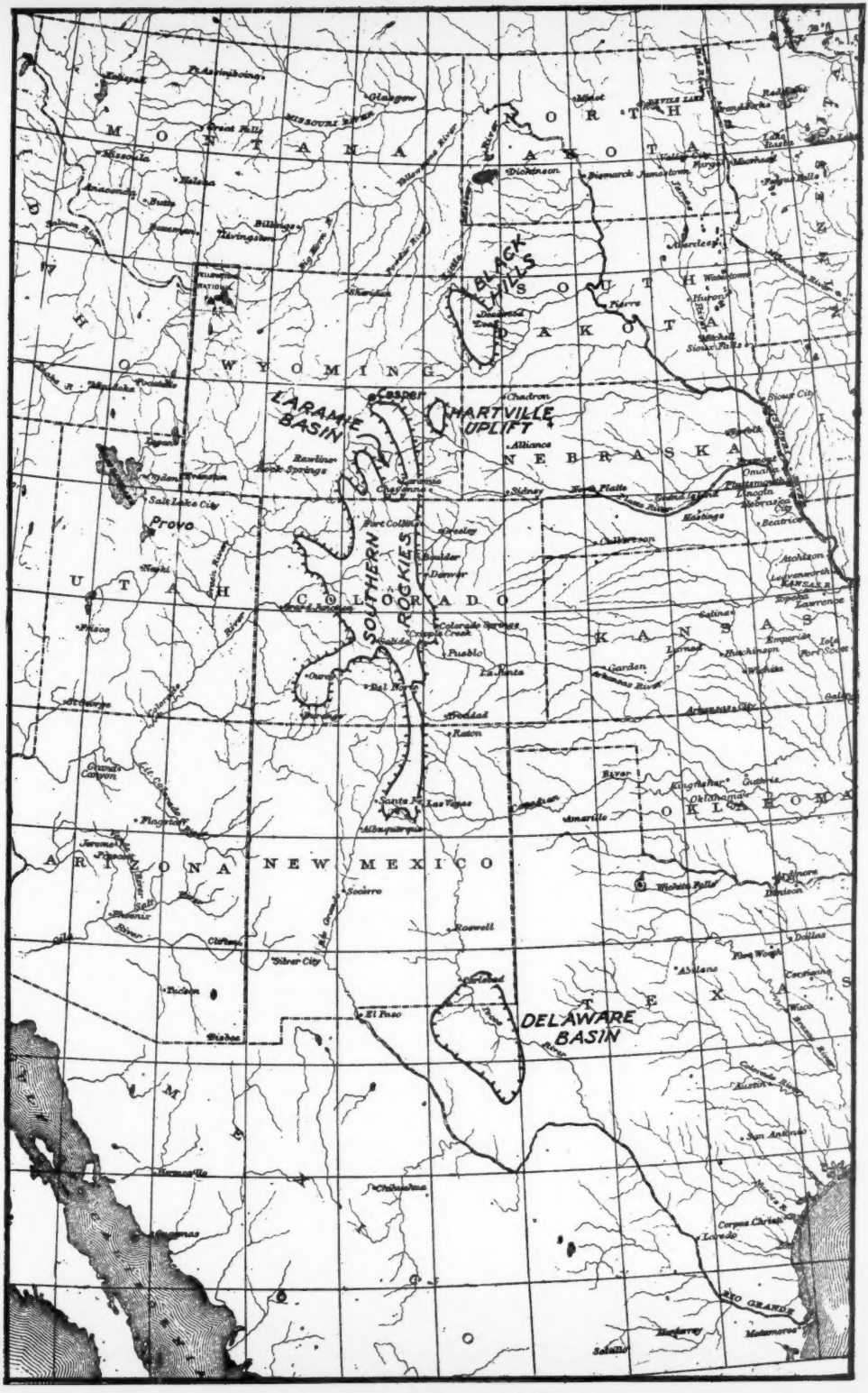

FIG. 1.—Western Interior United States.

In a section exposed in Red Bird Canyon,[12] on the southwest flank of the Black Hills, in South Dakota, 13 miles east-southeast of Newcastle, Wyoming, the so-called "Opeche" is about 125 feet thick. Its base is assumed to be at the eroded top of a limestone member of the Minnelusa. The "Opeche" here consists of the following.

	Approximate Thickness in Feet
Red sandy shale	50
White blocky sandstone	25
Reddish to brownish massive sandstone	20
Red massive sandstone, breccia at base	30

The median white sandstone has at times been called "Tensleep," on account of its appearance and its stratigraphic position relative to an overlying "Embar" (to wit, Opeche redbeds with a local gypsum lentil, Minnekahta limestone, and overlying calcareous gypsiferous beds).

In the Hartville uplift, in Sec. 28, T. 29 N., R. 67 W., 3 miles northeast of Cassa, Platte County, Wyoming, the "Opeche" is 60 feet thick,[13] and consists mainly of red sandy shale with the purple member at the top. The summarized section follows.

	Feet
Minnekahta limestone	28
Opeche red sandy shale	60
Hartville formation	
F. Yellow-buff sandstone	34
E. Red sandstone (8-foot yellow-buff sandstone parting)	99
D. Gray to pink to red siltstone (7-foot limestone in lower part)	83
C. Light gray limestone (4-foot red shale parting)	27
B. Red sandstone (2½-foot limestone parting)	39
A. Limestones, *et cetera*	

Units B, C, D, E, F constitute "Division I" of the Hartville formation. The top of unit F is the top of the Hartville by original definition. Unit A is the top member of "Division II," the fossils of which are unquestionably Pennsylvanian. The age of "Division I" is not settled.

The 34-foot yellow-buff sandstone (unit F) appears to be the counterpart of the "white blocky sandstone" in the so-called "Opeche" section of Red Bird Canyon, hereinbefore described.

Unit D has been described as "red-stained, calcareous, very massive, heterogeneous, grades from limestone to sandstone, with included angular cobbles of limestone and siltstone, locally cavernous." This resembles the brecciated members of the Minnelusa in the Hot Brook Canyon section.

[12] *Guide Book*, Fig. 27, p. 45.

[13] *Guide Book*, Fig. 33, p. 56.

Twenty-five miles west is the Labonte Creek section[14] in Converse County, Wyoming, as follows.

	Feet
Minnekahta limestone	23
Opeche red shale (purple at top)	64
Casper formation (122 feet soft, cross-bedded pink, buff and cream-colored sandstone at top)	879

It is suspected that all the Casper formation is Pennsylvanian and that in extending westward the top of the Casper is occupied by older and older members. There is thus a suspicion, at least, of hiatus between the Permian and Pennsylvanian from Labonte Creek westward to western Wyoming.

What is the relation between upper Hartville and upper Minnelusa? Alternatives were suggested during the discussion at the Centennial correlation meeting: (1) that the sandstones at the top of the Hartville (units D and F), and in the lower 75 feet of the alleged "Opeche" of Red Bird Canyon, and in the lower 93 feet of the alleged "Opeche" of Hot Brook Canyon wedge out so as to be represented in the northeast flank of the Black Hills by hiatus between the typical Opeche and typical Minnelusa; or (2) that these sandstones are correlatives of the upper part of the typical Minnelusa.

This part of the section is considered as possibly Permian in age.

The rest of Hartville I (upper Minnelusa) might also be Permian. Hartville II is Pennsylvanian (Virgil and Missouri).

BLACK HILLS–MID-CONTINENT CORRELATIONS

Now, as to correlation between the Black Hills and Kansas. The very starting point is still under debate. There are three main alternative assumptions: the Minnekahta is approximately (1) Day Creek, (2) Blaine, or (3) Stone Corral.

The third possibility was not very seriously advocated at the Centennial correlation meeting.

In advocating the following correlations, the proponents did not mean that the top and bottom horizons of each bed are precisely the same as the top and bottom horizons of the correlative bed. Rather they meant that the two beds are components of equivalent sections.

One correlation proposed was the following.

Mid-Continent		*Wyoming*
Day Creek	in same general section as	Minnekahta
Blaine	equivalent to part of	Opeche
Stone Corral	equivalent to some member of	Hartville I

[14] *Guide Book*, Fig. 51, p. 84.

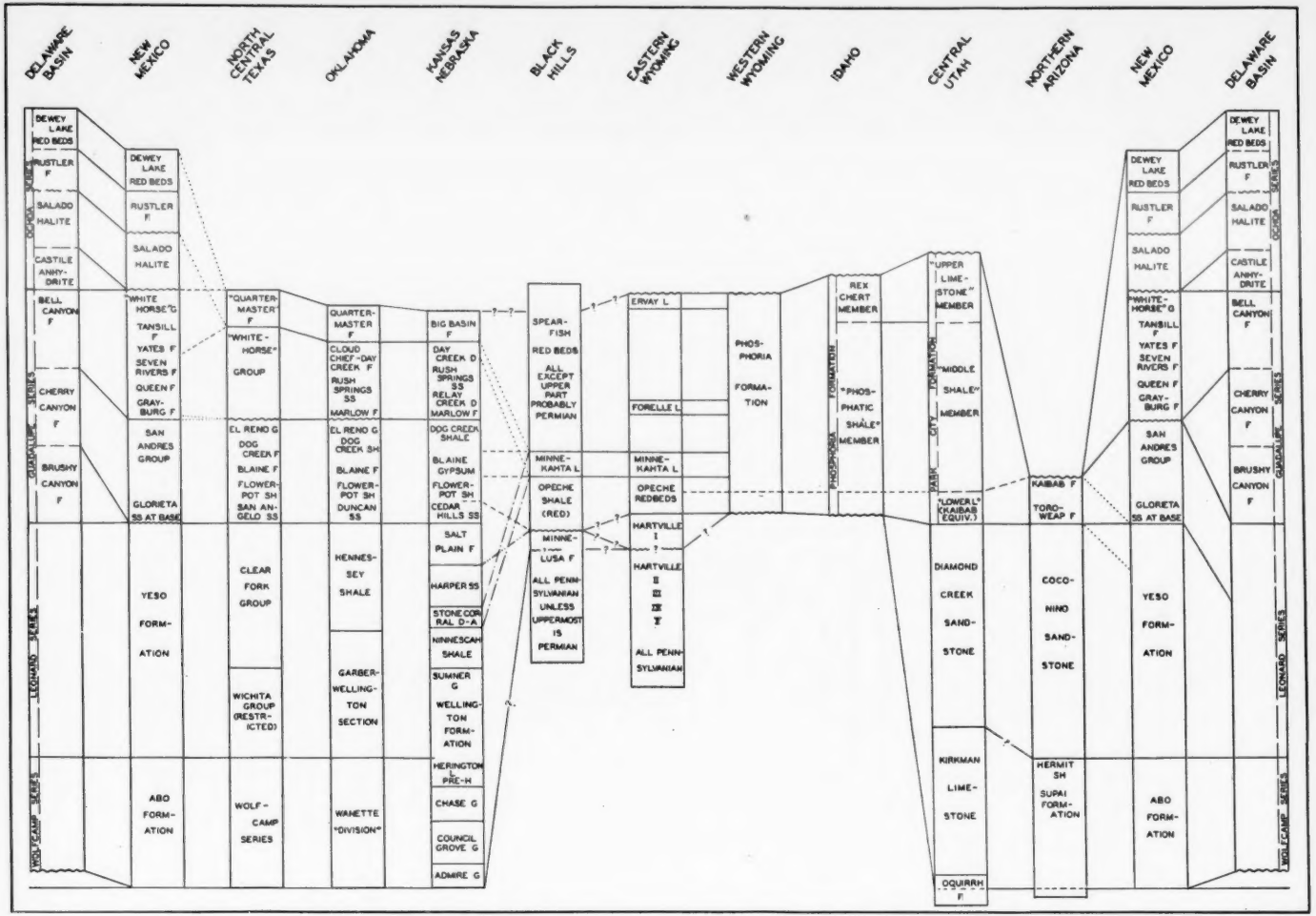

FIG. 2.—Permian correlation chart, Western Interior United States. Abbreviations: *F*=formation; *G*=group; *SS*=sandstone; *SH*=shale; *L*=limestone; *D*=dolomite; *A*=anhydrite; *PRE-H*=pre-Herington.

The following is another statement of practically the same correlation.

Wyoming	*Mid-Continent*
Minnekahta	Day Creek
Opeche	Blaine
Converse (upper Hartville I)	Cedar Hills
Anhydrite	Stone Corral
Black shale—dolomite	Chase group

A different correlation was also proposed.

Black Hills-Wyoming		*Mid-Continent*
Spearfish	has lithology of	Whitehorse
Minnekahta		Blaine
Opeche shale under Minnekahta	has lithology of	Flower-pot
Buff sandstone (at top of Hartville I*)	looks like	Cedar Hills
Brownish red sandstone** of Hartville I	may be	Harper

* That is, Unit F of the section northeast of Cassa previously described.
** Unit E.

TEXAS TO BLACK HILLS VIA OKLAHOMA

In the Black Hills–Wyoming country is the junction between the Mid-Continent Permian and the Permian of Utah and Arizona (Fig. 1). The different suggested correlations have different consequences relative to the correlation of the whole Permian system of the western United States (Fig. 2). It is interesting to examine these consequences by attempting to carry correlations southward from Nebraska to Texas, thence westward through New Mexico to Arizona, thence northward through Utah to western Wyoming, thence eastward through Wyoming and the Black Hills to the place of beginning. Or, better perhaps, start with the proposed standard section in West Texas and work both ways to the Black Hills.

The San Andres problem is a central problem in interregional correlation. Is the San Andres Guadalupe or Leonard? At the left side of the correlation chart (Fig. 2) it is shown as Guadalupe; at the right as Leonard. If it is Leonard, it is upper Leonard; if Guadalupe, middle Guadalupe (Cherry Canyon). The lower Guadalupe (Brushy Canyon) pinches out against the north rim of the Delaware basin.

The correlation from New Mexico to Kansas-Nebraska has been discussed many times in meetings and published articles. Recently Robert Roth[15] has announced the discovery of fossils in the putative Quartermaster of Briscoe County, Texas. These have been identified as Permian by Norman D. Newell.[16]

If the Quartermaster be Permian, it may represent beds equivalent to the Tansill-Yates section of New Mexico, or it may be equivalent to the Dewey Lake. On a recent field trip[17] Vaughn W. Russom, who

[15] Personal communication.

[16] Personal communication.

[17] Fall field trip, West Texas Geological Society, Eddy County, New Mexico, September 28–29, 1940, road log, p. 2, Stop 2.

has been engaged in mapping the Oklahoma redbeds for many years, remarked the striking similarity in appearance of the Dewey Lake outcrops near Carlsbad, New Mexico, to the Quartermaster of Oklahoma. They might be the same. The Dewey Lake redbeds above the Rustler formation were called Quartermaster by some of the pioneer oil geologists of New Mexico. It is conceivable that the Quartermaster contains both Dewey Lake and Rustler equivalents.

WYOMING TO TEXAS VIA ARIZONA

In the other half of the circuit, from the Black Hills through Utah to West Texas, certain paleontologic and stratigraphic data bear repeating.

After a monographic study of West Texas brachiopods Robert E. King[18] thought that the Phosphoria fauna was probably Word (middle Guadalupe) in age, whereas McKee[19] would call the middle Phosphoria *Pustula* fauna Kaibab and therefore Leonard.

Miller and Cline,[20] after studying the ammonoids about 150 feet above the base of the Phosphoria section in the Sublette Range, Wyoming, favored a Word (Guadalupe) age for these fossils, but stated that they might be as old as Leonard.

Renfro[21] recently redescribed a pelecypod fauna from the lowermost Permian at the southern end of the Laramie basin, Wyoming, pointing out that identical forms occur in the Kaibab of Arizona. The horizon of this collection is below the Minnekahta, and for that reason is presumably equivalent to the basal Phosphoria of western Wyoming.

In central Utah, near Provo, Baker and Williams[22] found probable Phosphoria equivalents resting on a limestone that bears a Kaibab fauna.

[18] Robert E. King, "Geology of the Glass Mountains, Texas, Part II," *Univ. Texas Bull. 3042* (November 8, 1930), pp. 30–33.

[19] Edwin D. McKee, "The Environment and History of the Toroweap and Kiabab Formations of Northern Arizona and Southern Utah," *Carnegie Inst. Washington Pub. 492* (1938), p. 176.

[20] A. K. Miller and L. M. Cline, "The Cephalopods of the Phosphoria Formation of Northwestern United States," *Jour. Paleontology*, Vol. 8, No. 3 (September, 1934), p. 284.

[21] Cited in H. D. Thomas, "Pennsylvanian and Permian Stratigraphy of Central and Southeastern Wyoming," *Guide Book 14th Annual Field Conference Kansas Geol. Soc.* (1940), p. 122. Renfro's paper is listed by title in *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No. 5 (May, 1940), p. 903.

[22] Arthur A. Baker and James Steele Williams, "Permian in Parts of Rocky Mountain and Colorado Plateau Regions," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, No.4 (April, 1940), pp. 624–25.

The Kaibab is commonly correlated with the San Andres. It can conceivably be upper Yeso.

ALTERNATIVE HYPOTHESES

With these data in mind, the following possibilities are proposed as subjects for study and speculation.

I. Minnekahta is Day Creek, therefore upper Guadalupe (Bell Canyon). All the Phosphoria of western Wyoming, except the very basal part, is therefore as young as upper Guadalupe (Bell Canyon). Some may be even younger (Ochoa).

II. Minnekahta is Blaine. San Andres is Leonard. Therefore the lower part, at least, of the Phosphoria is Leonard and probably equivalent to the Kaibab.

III. Minnekahta is Blaine. San Andres is Guadalupe. Therefore Phosphoria is Guadalupe, except the very basal part, which may be Kaibab, which may be Leonard.

IV. Minnekahta is Stone Corral, therefore Leonard. The lower Phosphoria, at least, is Leonard and correlative with the Kaibab, which must, therefore, be older than San Andres.

There is, of course, nothing final about the correlation chart or this discussion, the purpose of which is not to solve problems but to broaden the attack by stating them in regional terms. Another important line of correlations that must not be overlooked runs from eastern Wyoming southward along the eastern flank of the southern Rockies in Colorado and New Mexico (Fig. 1). Cross ties from that line must be made through the subsurface to Kansas, Oklahoma, and the Texas Panhandle. Another possible line would extend from central New Mexico northward via the Nacimiento Mountains to southwestern Colorado. Many cross ties have been and are being made in the Arizona, Nevada, Utah, and western Colorado country.

FURTHER WORK

More work is needed on the exceedingly important link between the Black Hills and the Mid-Continent. At the Centennial meeting it was agreed that Anthony Folger should continue his work as director of the distribution of key sets of critical samples. It is hoped that a second correlation meeting can be held during the convention in Houston in April.

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REVIEWS AND NEW PUBLICATIONS

* Subjects indicated by asterisk are in the Association library and available, for loan, to members and associates.

RECENT PUBLICATIONS

ALASKA

*"The Geology of the Antarctic Continent and Its Relationship to Neighbouring Land Areas," by Arthur Wade. *Proc. Roy. Soc. Queensland*, Vol. 52, No. 4 (Brisbane, 1940). 12 pp., 2 pls.

AUSTRALIA

*"Upper Devonian Goniatite Succession of Western Australia," by Curt Teichert. *Amer. Jour. Sci.*, Vol. 239, No. 2 (New Haven, Connecticut, February, 1941), pp. 148–53.

BRAZIL

**Brazil, 1939–40, an Economic, Social, and Geographic Survey*, compiled by José Jobim. *Ministry of Foreign Affairs* (Rio de Janeiro, 1940). 383 pp., 12 figs., 34 photographs, many statistical tables.

CALIFORNIA

*"Central San Joaquin Valley," compiled by *Oil and Gas Jour.*, Vol. 39, No. 35 (Tulsa, January 9, 1941), pp. 50–51; map and columnar sections in colors.

*"Recognition of Faults in Southern California," by W. J. Miller. Studies for students. *Jour. Geol.*, Vol. 49, No. 1 (Chicago, January-February, 1941), pp. 87–100.

EGYPT

*"Der geologische Bau und die Erdölvorkommen Ägyptens" (Geological Structure and Petroleum Prospects of Egypt), by H. Bürgl. *Oel und Kohle*, Vol. 36, No. 45 (Berlin, December 1, 1940), pp. 495–99; 5 figs., 1 table.

ENGLAND

*"The Carboniferous Limestone of the Castleton-Bradwell Area, North Derbyshire," by Jack Shirley and Ernest Lockwood Horsfield. *Quar. Jour. Geol. Soc. London*, Vol. 96, Pt. 3, No. 383 (November 30, 1940), pp. 271–99; 2 figs., 1 pl.

GENERAL

*"Nomenclature and Correlation of the North American Continental Tertiary," by H. E. Wood, 2nd, chairman, *et al. Bull. Geol. Soc. America*, Vol. 52, No. 1 (New York, January 1, 1941), pp. 1–48; correlation chart.

*"Shallow-Water Globigerina Sediments," by G. W. Crickmay, H. S. Ladd, and J. E. Hoffmeister. *Ibid.*, pp. 79–106; 4 figs., 2 pls.

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*"Drilling Wells Horizontally," by Leo Ranney. *Oil Weekly*, Vol. 100, No. 7 (Houston, January 20, 1941), pp. 12–14; 4 photographs.

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*"Small Foraminifera from the Late Tertiary of the Nederlands East Indies," by L. W. LeRoy. *Colorado School of Mines Quar.*, Vol. 36, No. 1 (Golden, January, 1941). 132 pp., 13 pls., 12 figs. Price, $2.00.

*"A Field Method for Determining the Magnetic Susceptibility of Rocks," by R. C. Hyslop. *A.I.M.E. Tech. Pub. 1285* (New York, February, 1941). 4 pp., 6 figs.

*"Effect of Dipping Strata on Determinations of Potential-Drop Ratio," by Maynard H. Jameson. *A.I.M.E. Tech. Pub. 1294* (February, 1941). 5 pp., 6 figs.

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*"Petroleum Engineering Education," by Harry H. Power. *A.I.M.E. Tech. Pub. 1312* (New York, 1941). 5 pp.

The Petroleum Industry: an Economic Survey, by Ronald B. Shuman. 298 pp., 14 figs., 48 tables. University of Oklahoma Press, Norman (1941). Price, $3.00.

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*"Erdöl und Luftbild" (Petroleum and Aerial Photography), by R. Baring. *Oel und Kohle*, Vol. 36, No. 46 (Berlin, December 8, 1940), pp. 519–20; 1 photograph.

*"A New Method of Constructing Subsurface Models," by Kenneth M. Bravinder, Dean H. Sheldon, and Jonathan E. Koogle. *Amer. Inst. Min. Met. Eng. Petrol. Tech.*, Vol. 4, No. 1 (New York, January, 1941). *Tech. Paper 1271*. 4 pp., 4 figs.

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*"Mississippian Basin of Northern Mid-Continent Region," by Joseph A. Kornfeld. *Pan-Amer. Geologist*, Vol. 75, No. 1 (Des Moines, Iowa, February, 1941), pp. 8–18; map of Mississippian subsurface structure in Oklahoma.

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*"Algenreste als mögliches Urmaterial zur Erdölbildung (Algal Remains as Possible Source Material in the Formation of Petroleum)," by K. Kalicki. *Ibid.*, No. 13 (1940). 70 pp., 4 tables. In Russian.

GULF COAST

*"Better Concept of Faulting Patterns Aids Piercement Salt Dome Development," by M. M. Kornfeld. *Oil Weekly*, Vol. 100, No. 10 (Houston, February 10, 1941), pp. 19–20; 3 figs.

ILLINOIS

*"Analyses of Some Illinois Crude Oils," by Harold M. Smith. *U. S. Bur. Mines R. I. 3532* (Washington, D. C., December, 1940). 27 multigraphed pp., 2 tables, 1 fig., 42 analyses.

Oil and Gas Development Map of Greenup Area (Ts. 7–9 N., Rs. 9–11 E., 14 W.); *Thompsonville* (Ts. 7–9 S., Rs. 3–5 E.). *Illinois Geol. Survey*. Blueline prints obtainable from map agent, 100 Natural Resources Building, Urbana, Illinois. Price, $0.60 (stamps *not* acceptable).

"Geology and Oil Possibilities of Extreme Southern Illinois" (Union, Johnson, Pope, Hardin, Alexander, Pulaski, and Massac counties), by J. Marvin Weller. *Illinois Geol. Survey R. I. 71* (Urbana, February, 1941). 71 pp., 1 fig., 1 pl. (structure-contour map). Price, $0.25.

ITALY

*"Geologie und Erschliessung der Erdölvorkommen Italiens" (Geology and Petroleum Prospects of Italy), by R. B. Behrmann. *Oel und Kohle*, Vol. 36, No. 46 (Berlin, December 8, 1940), pp. 522–37; 11 figs.

KANSAS

*"Stratigraphic Traps Source of Major Production over Central Kansas Uplift," by Joseph A. Kornfeld. *Oil Weekly*, Vol. 100, No. 6 (Houston, January 13, 1941), pp. 13–19; 2 tables, 3 maps. *Ibid.*, Vol. 100, No. 7 (January 20), pp. 20–30; 2 tables, 4 maps.

MINNESOTA

*"Subsurface Structure of the Paleozoic Rocks of Southeastern Minnesota," by G. A. Thiel and G. M. Schwartz. *Bull. Geol. Soc. America*, Vol. 52, No. 1 (New York, January 1, 1941), pp. 49–60; 5 figs., 1 pl.

MISSISSIPPI

*"Southern Mississippi," compiled by *Oil and Gas Jour.* Vol. 39, No. 39 (Tulsa, February 6, 1941), pp. 42–43; geological map and stratigraphic columns in colors.

NEBRASKA

*"Southeastern Nebraska," compiled by *Oil and Gas Jour.*, Vol. 39, No. 37 (Tulsa, January 23, 1941), pp. 42–43; map and log sections in colors.

NEW MEXICO

*"Tectonics of Sierra San Andres of New Mexico," by Charles Laurence Baker. *Pan-Amer. Geologist*, Vol. 55, No. 1 (Des Moines, Iowa, February, 1941), pp. 53–56; 2 photographs.

RUSSIA

*"Geological Structure and Oil-Bearing Formations in the Region of the Middle Course of the River Maya (Ayan-Maya District, Far Eastern Region)," by S. Alexeychik. *Trans. Geol. Oil Inst.*, N. S., No. 2 (Moscow, 1940). 33 pp., geologic map and stratigraphic column. In Russian.

*"Map of the Prospects of Oil-Bearing Formations of the Asiatic Part of U.S.S.R.," by N. Gedroytz. *Ibid.*, No. 3 (1940), 31 pp. Folded geologic map. In Russian.

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*"Materials of the Laboratory of Bitumens." 3 articles. *Ibid.*, No. 8 (1940). 39 pp., 7 tables. In Russian.

*"Geological Investigations in the Zone of Oil-Ilezkayazaschita of the Emba Oil-Bearing District," by N. Khramov. *Ibid.*, No. 11 (1940). 43 pp., 13 figs. In Russian.

*"Several Species of Pelecypods from the Upper Paleogene of the Tadjik Depression," by E. Ivanova. *Ibid.*, No. 12 (1940). 28 pp., 1 fossil pl. In Russian. Pp. 25–27, English summary.

TURKEY

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*"Possibilities of Petroleum Discoveries," by C. E. Taşman. *Ibid.*, pp. 570–71. In Turkish.

*"Genesis and Mother Substance of Petroleum," by M. R. Mutuk. *Ibid.*, pp. 572–79. In Turkish.

*"Geological Excursions in the Vicinity of Ankara. Part II, Western and Northern," by W. Salomon-Calvi. *Ibid.*, pp. 610–19. In German.

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THE ASSOCIATION ROUND TABLE

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The executive committee has approved for publication the names of the following candidates for membership in the Association. This does not constitute an election but places the names before the membership at large. If any member has information bearing on the qualifications of these nominees, he should send it promptly to the Executive Committee, Box 979, Tulsa, Oklahoma. (Names of sponsors are placed beneath the name of each nominee.)

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1941	1942	1943
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E. E. ROSAIRE	CHALMER J. ROY	H. S. MCQUEEN
	EARL A. TRAGER	B. B. WEATHERBY

SPECIAL COMMITTEES

COMMITTEE ON COLLEGE CURRICULA IN GEOLOGY

FREDERIC H. LAHEE, *chairman*, Sun Oil Company, Dallas, Texas

L. T. BARROW	WINTHROP P. HAYNES	JOHN D. MARR
WALTER R. BERGER	K. K. LANDES	E. K. SOPER
HAL P. BYBEE	JOHN T. LONSDALE	W. T. THOM, JR.
IRA H. CRAM		

COMMITTEE TO RECOMMEND A NEW METHOD OF ELECTING OFFICERS

GEORGE S. BUCHANAN, *chairman*, Box 2199, Houston, Texas

N. WOOD BASS	J. V. HOWELL	JOHN N. TROXELL
GLENN C. CLARK	L. C. MORGAN	W. B. WILSON

COMMITTEE ON MIMEOGRAPHED PUBLICATIONS

FRANK R. CLARK, *chairman*, The Ohio Oil Company, Tulsa, Oklahoma

ARTHUR E. BRAINERD	FREDERIC H. LAHEE	E. FLOYD MILLER
GEORGE S. BUCHANAN	A. I. LEVORSEN	FRANK A. MORGAN

FINANCAL STATEMENT FOR YEAR 1940

To the Executive Committee,
The American Association of Petroleum Geologists,
Tulsa, Oklahoma.

DEAR SIRS:

In continuation of our examinations in prior years we have examined the accounting records of *The American Association of Petroleum Geologists* for the year ended December 31, 1940, and now submit our report together with the following statements:

Exhibit	
A	Statement of Financial Condition, December 31, 1940
B	Statement of Income for the year ended December 31, 1940
Schedule	
*1	Statement of Investments, December 31, 1940
2	Statement of Income from Publications for the year ended December 31, 1940
3	Statement of General and Administrative Expenses for the year ended December 31, 1940

In connection with our examination, we reviewed the system of internal control and the accounting procedures of the Association and, without making a detailed audit of the transactions, examined or tested accounting records of the Association and other supporting evidence, by methods and to the extent we deemed appropriate.

Demand deposits were reconciled to certificates received directly from the depositories. Reserves of $1,145.51 provided for doubtful accounts receivable appear adequate. In accordance with resolution adopted by the Executive Committee and consistent with the preceding year, publications on hand as shown by the records were priced at appraised values and a reserve provided for excessive quantities and old numbers; we made extensive tests of inventory quantities and computations. Investments are stated at market which is $7,733.64 less than cost; at December 31, 1939, investments were stated at the lower of cost or market and if this basis had been followed at December 31, 1940, the stated value of investments would have been reduced by $1,517.25 with a corresponding reduction in net income for the year 1940. Confirmation of certificates of securities in the custody of The New York Trust Company at December 31, 1940, was received directly from the custodian.

In our opinion, the accompanying statement of financial condition and related statement of income, supplemented by the supporting schedules, present fairly the position of The American Association of Petroleum Geologists at December 31, 1940, and the results of its operations for the year, in conformity with generally accepted accounting principles applied, with the exception of the valuation of investments referred to in the preceding paragraph, on a basis consistent with that of the preceding year.

(Signed) ARTHUR YOUNG & COMPANY, *Accountants and Auditors*

TULSA, OKLAHOMA
February 6, 1941

* Schedule 1 is not here published.

EXHIBIT A

STATEMENT OF FINANCIAL CONDITION, DECEMBER 31, 1940

ASSETS	*Total*	*General Fund*	*Publication Fund*	*Research Fund*
CURRENT ASSETS:				
Demand deposits—				
The First National Bank and Trust Company, Tulsa, Oklahoma	$ 18,164.33	$10,483.70	$ 5,985.40	$1,695.23
National Bank of Commerce, Tulsa, Oklahoma	907.01	907.01	—	—
TOTAL CASH IN BANKS	$ 19,071.34	$11,390.71	$ 5,985.40	$1,695.23
Accounts receivable—				
Membership dues (less reserve $759.32)	$ 759.32	$ 759.32	$ —	$ —
Advertising	757.50	757.50	—	—
Due from The New York Trust Company	569.20	414.68	154.52	—
Other accounts receivable (less reserves $386.19)	193.09	118.50	74.59	—
TOTAL ACCOUNTS RECEIVABLE	$ 2,279.11	$ 2,050.00	$ 229.11	$ —
Accrued interest receivable (less reserve $465.41)	$ 212.84	$ 159.86	$ 27.33	$ 25.65
Inventory of publications (less reserve $21,157.96)—see report	$ 15,659.11	$ 9.525.16	$ 6,133.95	$ —
TOTAL CURRENT ASSETS	$ 37,222.40	$23,125.73	$12,375.79	$1,720.88
INVESTMENTS (at market)	$ 73,987.34	$57,418.34	$14,275.03	$2,293.97
FURNITURE AND FIXTURES (less reserve $4,065.66)	$ 1.00	$ 1.00	$ —	$ —
PREPAID AND DEFERRED CHARGES:				
Printing in progress	$ 568.53	$ 568.53	$ —	$ —
Other prepaid and deferred charges	121.10	121.10	—	—
TOTAL PREPAID AND DEFERRED CHARGES	$ 689.63	$ 689.63	$ —	$ —
TOTAL ASSETS	$111,900.37	$81,234.70	$26,650.82	$4,014.85

LIABILITIES AND SURPLUS	*Total*	*General Fund*	*Publication Fund*	*Research Fund*
CURRENT LIABILITIES:				
Accounts payable	$ 2,044.82	$ 2,044.82	$ —	$ —
Accrued printer's charges	568.53	568.53	—	—
TOTAL CURRENT LIABILITIES	$ 2,613.35	$ 2,613.35	$ —	$ —
DEFERRED INCOME:				
Memberships and subscriptions—				
Active memberships	$ 7,785.22	$ 7,785.22	$ —	$ —
Associate memberships	1,246.00	1,246.00	—	—
Subscriptions to Bulletin	2,415.75	2,415.75	—	—
	$ 11,446.97	$11,446.97	$ —	$ —
Advertising	452.50	452.50	—	—
TOTAL DEFERRED INCOME	$ 11,899.47	$11,899.47	$ —	$ —
SURPLUS:				
Balance, December 31, 1939	$ 96,374.45	$66,995.64	$27,047.21	$2,331.60
Transferred from General Fund to Research Fund	—	*—2,600.00*	—	2,600.00
	$ 96,374.45	$64,395.64	$27,047.21	$4,931.60
Net income—*loss* for the year ended December 31, 1940—Exhibit B	1,013.10	2,326.24	*—396.93*	*—916.75*
Balance, December 31, 1940	$ 97,387.55	$66,721.88	$26,650.82	$4,014.85
CONTINGENT LIABILITIES:				
All known liabilities of the Association at December 31, 1940, were recorded in the accounts and no litigation was pending at that date				
TOTAL LIABILITIES AND SURPLUS	$111,900.37	$81,234.70	$26,650.82	$4,014.85

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

EXHIBIT B

STATEMENT OF INCOME FOR THE YEAR ENDED DECEMBER 31, 1940

	Members	*Annual Dues*	*Total*		*General Fund*		*Publication Fund*		*Research Fund*	
OPERATING INCOME:										
Dues for current period—										
Active memberships	2,659	$10.00		$26,590.00		$26,590.00		$ —		$ —
Associate memberships—										
Less than three years	592	6.00	$3,552.00		$3,552.00		$ —		$ —	
Three to six years	99	8.00	792.00		792.00		—		—	
Over six years	39	10.00	390.00	4,734.00	390.00	4,734.00	—	—	—	—
				$31,324.00		$31,324.00		$ —		$ —
Less: Transferred to "Income from Publications" ($6.00 per member)				20,334.00		20,334.00		—		—
				$10,990.00		$10,990.00		$ —		$ —
Net income from publications—Schedule 2				7,206.64		6,363.16		843.48		—
				$18,196.64		$17,353.16		$ 843.48		$ —
GENERAL AND ADMINISTRATIVE EXPENSES—										
Schedule 3				16,516.82		16,495.07		21.75		—
				$ 1,679.82		$ 858.09		$ 821.73		$ —
OTHER INCOME:										
Income from investments			$2,317.56		$1,755.79		$ 478.19		$ 83.58	
Recovery of accounts previously charged off			380.25		380.25		—		—	
Net profit on sale of investments			222.51		177.51		45.00		—	
Miscellaneous			152.43	3,072.75	152.43	2,465.98	—	523.19	—	83.58
				$ 4,752.57		$ 3,324.07		$1,344.92		$ 83.58
INCOME DEDUCTIONS:										
Adjustment of stated value of investments to market			$2,500.53		$ 896.72		$1,741.31		$*—137.50*	
Research projects—										
Bass-Neumann's Oil Analysis			811.61		—		—		811.61	
Whitehead's Radio Activity of Oil and Gas			300.00		—		—		300.00	
Waldschmidt's Core Analysis			26.22		—		—		26.22	
Convention expenses—net			55.61		55.61		—		—	
Miscellaneous			45.50	3,739.47	45.50	997.83	—	1,741.31	—	1,000.33
NET INCOME—*LOSS*				$ 1,013.10		$ 2,326.24		$—*396.39*		$—*916.75*

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

SCHEDULE 2

STATEMENT OF INCOME FROM PUBLICATIONS FOR THE YEAR ENDED DECEMBER 31, 1940

	Total		*General Fund*		*Publication Fund*	
OPERATING INCOME:						
Dues transferred		$20,334.00		$20,334.00		$ —
Bulletin subscriptions		4,420.76		4,420.76		—
Advertising		7,199.03		7,199.03		—
Sales of bound volumes and special publications—						
Bound volumes of Bulletin	$ 3,483.10		$ 3,483.10		$ —	
Back numbers of Bulletin	2,042.94		2,042.94		—	
Typical American Oil Fields Volume II	40.60		40.60		—	
Geology of Natural Gas	522.72		—		522.72	
Geology of Tampico Region	129.10		—		129.10	
Gulf Coast Oil Fields	462.00		—		462.00	
Structural Evolution of Southern California	111.44		—		111.44	
Miocene Stratigraphy of California	340.30		—		340.30	
Recent Marine Sediments	2,105.15		—		2,105.15	
Tectonic Map of Southern California	24.20		—		24.20	
Comprehensive Index	51.10		51.10		—	
Regional Cross Sections	534.55		534.55		—	
Other publications	86.49	9,933.69	86.49	6,238.78	—	3,694.91
TOTAL INCOME		$41,887.48		$38,192.57		$3,694.91
COSTS AND EXPENSES:						
Proportion of manager's salary	$ 3,750.00		$ 3,750.00		$ —	
Editorial salaries	3,975.00		3,975.00		—	
Printing Bulletins	17,914.26		17,914.26		—	
Engraving	2,654.54		2,654.54		—	
Stencil corrections and mailing	218.23		218.23		—	
Bulletin mailing and express	1,232.36		1,232.36		—	
Copyright fees	24.00		24.00		—	
Reprints	377.61		377.61		—	
Binding Volume XXIII (1939)	583.79		583.79		—	
Regional cross sections	421.12		421.12		—	
National Research Council expense in connection with printing of Recent Marine Sediments	348.81		—		348.81	
Other publications—freight, express and postage	187.88		—		187.88	
Miscellaneous	52.34		—		52.34	
	$31,739.94		$31,150.91		$ 589.03	
Add: Inventory decrease	2,940.90		678.50		2,262.40	
TOTAL COSTS AND EXPENSES		34,680.84		31,829.41		2,851.43
NET INCOME FROM PUBLICATIONS		$ 7,206.64		$ 6,363.16		$ 843.48

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

SCHEDULE 3

STATEMENT OF GENERAL AND ADMINISTRATIVE EXPENSES
FOR THE YEAR ENDED DECEMBER 31, 1940

GENERAL FUND:	
Proportion of manager's salary	$ 3,750.00
Clerical salaries	5,831.90
Postage	2,036.86
Office rent	1,500.00
Office supplies and expenses	491.71
Printing and stationery	241.78
Telephone and telegraph	366.26
Insurance	237.32
Investment counsel	400.00
Audit expense	300.00
Freight and express	159.93
Bad debts	857.01
Depreciation of furniture and fixtures	209.04
Miscellaneous	113.26
	$16,495.07
PUBLICATION FUND:	
Miscellaneous	$ 21.75
TOTAL GENERAL AND ADMINISTRATIVE EXPENSES	$16,516.82

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

FINANCIAL STATEMENT, DIVISION OF PALEONTOLOGY AND MINERALOGY, FOR YEAR 1940

To the Council,
Society of Economic Paleontologists and Mineralogists,
Tulsa, Oklahoma.

DEAR SIRS:

In continuation of our examinations in prior years we have examined the accounting records of the Society of Economic Paleontologists and Mineralogists for the year ended December 31, 1940, and now submit our report together with the following statements:

Exhibit

A	Statement of Financial Condition, December 31, 1940
B	Statement of Income for the year ended December 31, 1940

Schedule

1	Statement of Receipts and Disbursements for the year ended December 31, 1940

In connection with our examination, we reviewed the system of internal control and the accounting procedures of the Society and, without making a detailed audit of the transactions, examined or tested accounting records of the Society and other supporting evidence, by methods and to the extent we deemed appropriate.

Demand and savings deposits were reconciled to certificates received directly from the depositories. Inventory of publications represents approximately 26,500 Journals (exclusive of Journals in excess of complete sets for issues prior to 1940) as shown by the records, including certain issues printed at the expense of the Paleontological Society for the years 1935 to 1940, inclusive, stated at appraised values of fifty cents each for Journals printed prior to 1940 or cost to either the Society of Economic Paleontologists and Mineralogists or the Paleontological Society for Journals printed in 1940. We made extensive tests of inventory quantities and computations.

The Society of Economic Paleontologists and Mineralogists has agreed to distribute a portion of its income to the Paleontological Society. Income accruing to the Paleontological Society for the year 1940 amounted to $313.64.

In our opinion, the accompanying statement of financial condition and related statement of income present fairly the position of the Society of Economic Paleontologists and Mineralogists at December 31, 1940, and the results of its operations for the year, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

(Signed) ARTHUR YOUNG & COMPANY, *Accountants and Auditors*

TULSA, OKLAHOMA
February 6, 1941

EXHIBIT A
STATEMENT OF FINANCIAL CONDITION
DECEMBER 31, 1940

ASSETS

CURRENT ASSETS:		
Demand deposits—		
The First National Bank and Trust Company, Tulsa, Oklahoma	$ 4,543.94	
National Bank of Commerce, Tulsa, Oklahoma	161.11	$ 4,705.05
Savings deposit—		
The First National Bank and Trust Company, Tulsa, Oklahoma		1,054.40
Accounts receivable—		
Printed matter	$ 96.80	
Advertising	41.23	138.03
Inventory of publications—see report		13,723.84
TOTAL CURRENT ASSETS		$19,621.32
FURNITURE AND FIXTURES	$ 482.60	
Less: Reserve for depreciation	144.20	338.40
PREPAID AND DEFERRED CHARGES		627.16
TOTAL ASSETS		$20,586.88

LIABILITIES AND SURPLUS

CURRENT LIABILITIES:		
Accounts payable		$ 500.89
Accrued printer's charges		627.16
Amount due to Paleontological Society		313.64
TOTAL CURRENT LIABILITIES		$ 1,441.69
DEFERRED INCOME:		
Subscriptions to Journals	$ 1,081.40	
Membership dues for 1941	767.00	1,848.40
SURPLUS:		
Balance, December 31, 1939	$17,052.74	
Net income for the year ended December 31, 1940—Exhibit B	244.05	
Balance, December 31, 1940		17,296.79
CONTINGENT LIABILITIES:		
All known liabilities of the Society at December 31, 1940, were recorded in the accounts and no litigation was pending at that date.		
TOTAL LIABILITIES AND SURPLUS		$20,586.88

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

EXHIBIT B
STATEMENT OF INCOME FOR THE YEAR ENDED
DECEMBER 31, 1940

INCOME:		
Dues and subscriptions—		
Journal of Paleontology and Sedimentary Petrology	$ 800.00	
Journal of Paleontology	2,906.63	
Journal of Sedimentary Petrology	875.67	$ 4,582.30
Sales of back numbers—		
Journal of Paleontology	$1,072.20	
Journal of Sedimentary Petrology	197.52	1,269.72
Sales of plates and reprints		219.01
Advertising		62.46
Interest on savings deposit		10.47
Recovery of accounts previously charged off		58.26
Other income		41.53
TOTAL INCOME		$ 6,243.75
Less: Proportion of income accrued to Paleontological Society		313.64
		$ 5,930.11
COSTS AND EXPENSES:		
Printing expenses—		
Journal of Paleontology	$2,673.17	
Journal of Sedimentary Petrology	1,067.23	$3,740.40
Postage and mailing		421.46
Office rent		300.00
Clerical salaries		700.00
Audit expense		100.00
Office supplies and expenses		143.32
Depreciation		48.26
Bad debts		29.37
Other costs and expenses		158.35
		$5,641.16
Decrease in inventory of publications		44.90
		5,686.06
NET INCOME		$ 244.05

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

SCHEDULE 1
STATEMENT OF RECEIPTS AND DISBURSEMENTS
FOR THE YEAR ENDED DECEMBER 31, 1940

DEMAND DEPOSITS, DECEMBER 31, 1939			$ 4,250.40
RECEIPTS:			
Membership dues and subscriptions—			
Year 1940—			
Journals of Paleontology and Sedimentary Petrology	$ 510.46		
Journal of Paleontology	1,713.72		
Journal of Sedimentary Petrology	493.27	$2,717.45	
Year 1941—			
Journals of Paleontology and Sedimentary Petrology	$ 352.00		
Journal of Paleontology	1,078.00		
Journal of Sedimentary Petrology	311.80	1,741.80	
Accounts receivable		508.11	
Sales of back numbers—			
Journal of Paleontology	$ 765.20		
Journal of Sedimentary Petrology	114.80	880.00	
Sales of plates		189.94	
Miscellaneous		352.72	6,390.02
			$10,640.42
DISBURSEMENTS:			
Printing expenses—			
Journal of Paleontology	$1,970.45		
Journal of Sedimentary Petrology	626.51		
Engraving Journal of Paleontology	598.46	$3,195.42	
Accounts payable		292.15	
Payment to Paleontological Society		395.23	
Editorial salaries		300.00	
Clerical salaries		700.00	
Audit expense		100.00	
Office supplies and expenses		65.52	
Postage and mailing		297.59	
Office rent		300.00	
Refunds on subscriptions		56.48	
Miscellaneous		232.98	5,935.37
DEMAND DEPOSITS, DECEMBER 31, 1940			$ 4,705.05

SUBJECT TO COMMENTS IN ACCOMPANYING REPORT

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 25 NO. 3 (MARCH, 1941), PP. 457-535

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS MEMBERSHIP LIST[1]

MARCH 6, 1941

HONORARY MEMBERS

The executive committee may from time to time elect as honorary members persons who have contributed distinguished service to the cause of petroleum geology. Honorary members shall not be required to pay dues.—*Sec. 6, Article III, of the Constitution.*

LIFE MEMBERS

The executive committee may grant life membership to members who have paid their dues and are otherwise qualified.—*Sec. 2, Article III, of the Constitution.*

On the payment of two hundred dollars ($200.00) any member in good standing shall be declared a life member and thereafter shall not be required to pay annual dues.—*Sec. 2, Article I, of the By-Laws.*

MEMBERS

Any person engaged in the work of petroleum geology or in research pertaining to petroleum geology or technology is eligible to active membership, provided he is a graduate of an institution of collegiate standing, in which institution he has done his major work in geology, or in sciences fundamental to petroleum geology, and in addition has had the equivalent of three years' experience in petroleum geology or in the application of these other sciences to petroleum geology or to research in petroleum geology or technology; and provided further that in the case of an applicant for membership who has not had the required collegiate or university training, but whose standing in the profession is well recognized, he shall be admitted to membership when his application shall have been favorably and unanimously acted upon by the executive committee, and provided further that these requirements shall not be construed to exclude teachers and research workers in recognized institutions whose work is of such character as in the opinion of the executive committee shall qualify them for membership.

Active members alone shall be known as members.—*Sec. 1, Article III, of the Constitution.*

ASSOCIATES

Any person having completed as much as thirty hours of geology (an hour shall here be interpreted as meaning as much as sixteen recitation or lecture periods of one hour each, or the equivalent in laboratory) in a reputable institution of collegiate or university standing, or who has done field work equivalent to this, is eligible to associate membership, provided, at the time of his application for membership he shall be engaged in geological studies in an institution of collegiate or university standing, or shall be engaged in petroleum geology; and any person who is a graduate of an institution of collegiate standing, in which he has done his major work in sciences fundamental to petroleum geology or petroleum technology, and who has had the equivalent of one year's experience in the application of his science to the study of petroleum geology, shall be eligible to associate membership, provided at the time of his application for membership he shall be engaged in investigations in the broader subject of petroleum geology and technology.

Associate members shall be known as associates.

Associates shall enjoy all the privileges of membership in the Association, save that they shall not hold office, sign applications for membership, or vote; neither shall they have the privilege of advertising their affiliation with the Association in professional cards or professional reports or otherwise.—*Sec. 3, Article III, of the Constitution.*

HONORARY MEMBERS

**Campbell, Marius R.
Darton, N. H., U. S. Geological Survey, Washington, D. C.
Decker, Charles E., 508 Chautauqua Ave., Norman, Okla.
**Dumble, E. T.

[1] This list is published for the use of the members and for the information of all who wish to refer to the professional and business affiliations of the members. It is not a mailing address list and it is not intended to be used for circularizing or soliciting purposes.

Goodrich, Harold B., 1628 S. Cincinnati, Tulsa, Okla.
Harris, Gilbert D., Dept. of Geology, Cornell University, Ithaca, N. Y.
Hill, Robert T., c/o Dallas News, Dallas, Tex.
Lawson, Andrew C., University of California, Bacon Hall, Berkeley, Calif.
Mendenhall, Walter C., U. S. Geological Survey, Washington, D. C.
Orcutt, W. W., Rancho Sombra del Roble, Canoga Park, Calif.
Ordoñez, Ezequiel, Abraham Gonzales 79, Mexico City, Mexico
**Reed, Ralph D.
**Salisbury, R. D.
Schuchert, Charles, Yale University, New Haven, Conn.
Smith, George Otis, Box 308, Skowhegan, Me.
Stille, Hans, Geological Institute, University of Berlin, Berlin, Germany
Taff, Joseph A., 628 Cowper St., Palo Alto, Calif.
**Udden, Johan August
Ulrich, E. O., National Museum, Washington, D. C.
van der Gracht, W.A.J.M., 36 Eeuwige Laan, Huize Jachtduin, Bergen (N.H.), Netherlands
**von Hofer, Hans Hofrat
**White, David
**White, I. C.

** Deceased.

COMPLETE LIST OF MEMBERS, ASSOCIATES, HONORARY MEMBERS, AND LIFE MEMBERS

Honorary	15
Life	4
Members	2,702
Associates	754
Total	3,475

EXPLANATION OF SYMBOLS

* Honorary member. † Life member. ‖ Associate. Members are not marked. The year refers to the date of election to membership.

‖Abell, George T., Tex-Mex Petr. Corp., Box 430, Midland, Tex. '29
Abbott, John L., Pritchard & Abbott, Century Bldg., Fort Worth, Tex. '27
Abernathy, G. E., 115 E. Williams, Pittsburg, Kan. '38
‖Absher, K. B., Box 240, Mattoon, Ill. '25
Absher, William F., Geol. Dept., Cities Service Oil Co., Bartlesville, Okla. '20
‖Acheson, Cyrus Harold, Tropical Oil Co., El Centro, Colombia, S. A. '39
Achning, Walter J., 1101 Milam Bldg., San Antonio, Tex. '38
Ackerman, E. Dumont, Standard Oil Co. of Venezuela, Caripito, Venezuela, S. A. '40
Ackers, A. L., Stanolind Oil & Gas Co., Box 591, Tulsa, Okla. '25
Ackley, Kenneth A., Carter Oil Co., Box 1151, Seminole, Okla. '38
Adams, Elmo W., Honolulu Oil Corp., 215 Market St., San Francisco, Calif. '30
Adams, Frank C., consulting, 902 Electric Bldg., Houston, Tex. '27
Adams, Kilburn E., The Texas Co., Box 2420, Tulsa, Okla. '38
Adams, John Emery, Standard Oil Co. of Texas, Box 71, Gretna, La. '29
Adams, W. C., Box 1666, Houston, Tex. '24
Addison, Carl C., Pure Oil Co., 402 Second Natl. Bank Bldg., Saginaw, Mich. '30
Adkins, W. S., Shell Oil Co., Inc., Box 2099, Houston, Tex. '20
‖Adkisson, Albert, producer, 2019 W. T. Waggoner Bldg., Fort Worth, Tex. '34
Adler, Joseph L., 2011 Esperson Bldg., Houston, Tex. '30
‖Afshar, Hadji Azadi, Khiaban Shahpur, Teheran, Iran. '39
Agee, Flint H., Box 608, Morgan City, La. '38
‖Agey, Charles S., Amerada Petr. Corp., Box 995, Wichita, Kan. '38
Agnich, Fred J., N. V. Nederlandsche Pac. Petr. Mij., Paleisweg 33, Medan, Sumatra, N. E. I. '41
Aguerrevere, Pedro I., Apt. 1253, Caracas, Venezuela, S. A. '24
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Wilson, F. Wayne, The Texas Co., Drawer B, Freer, Tex. '40
Wilson, Homer M., consulting, Box 250, Marathon, Tex. '27
Wilson, Ivan F., 2555 Virginia St., Berkeley, Calif. '41
‖Wilson, James, Jr., Shell Oil Co., Inc., 2000 Alamo Natl. Bldg., San Antonio, Tex. '40
Wilson, John H., Independent Exploration Co., 2015 Fort Worth Natl. Bank Bldg., Fort Worth, Tex. '21
Wilson, Joe G., The Texas Petr. Co., Apt. 877, Bogota, Colombia, S. A. '31
Wilson, Joseph M., 6235 Richmond Ave., Dallas, Tex. '22
Wilson, Malcolm E., General American Oil Co., Dallas, Tex. '20
Wilson, Richard M., The Ohio Oil Co., Box 1129, Shreveport, La. '38
Wilson, Thomas C., Apt. 376, Managua, Nicaragua, C. A. '30

Wilson, Walter B., Gulf Oil Corp., Box 661, Tulsa, Okla.....'21
Wimbish, Forrest E., Magnolia Petr. Co., Box 1882, Wichita, Kan.....'28
Wines, Donald Bradford, Tide Water Associated Oil Co., 1005 Brown Bldg., Wichita, Kan.....'29
Winfrey, Donald B., Petty Geophysical Eng. Co., Box 2061, San Antonio, Tex....'31
‖Wing, Robert B., Expl. Dept., Shell Oil Co., Inc., Box 2009, Wichita Falls, Tex..'38
Winham, W. P., Standard Oil Co. of Calif., Box 1200, Bakersfield, Calif.....'28
Winkler, B. O., c/o N.K.P.M., Palembang, Sumatra, N. E. I.....'31
Winkler, Hans, Sun Oil Co., Austin, Tex.....'31
‖Winkler, Virgil, 108 N. Busey Ave., Urbana, Ill.....'40
Winter, Niles B., Atlantic Refg. Co., Box 871, Midland, Tex.....'24
Winterer, Edward V., Superior Oil Co., 930 Edison Bldg., Los Angeles, Calif.....'27
Winton, Will M., Texas Christian University, Fort Worth, Tex.....'20
‖Winzeler, Alvin R., Stanolind Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan.....'40
Wiringa, Leon O., U. S. Geological Survey, Shreveport, La.....'37
Wissler, Stanley G., Union Oil Co. of Calif., Box 511, Compton, Calif.....'27
‖Witherspoon, Edgar, 423 S. Highland, Ada, Okla.....'40
Wofford, H. R., Jr., International Petr. Co., Box 803, Guayaquil, Ecuador, S. A...'35
Wolf, Albert G., Texas Gulf Sulphur Co., 1009 Second Natl. Bank Bldg., Houston, Tex.....'24
Wolters, Earl M., 3332 Columbine St., Denver, Colo.....'30
Womack, Brame, consulting, 203 S. Waverly Drive, Dallas, Tex.....'34
Wood, Fred E., Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago, Ill...'24
Wood, George R., Texas Petr. Co., Apt. Nacional 877, Bogota, Colombia, S. A....'30
Wood, James T., Jr., The Texas Co., 929 S. Broadway, Los Angeles, Calif.....'24
Wood, J. Pendleton, 475 Humboldt St., Denver, Colo.....'27
‖Wood, Owen Bishop, The Atlantic Refg. Co., 224 Nixon Bldg., Corpus Christi, Tex.'39
‖Woods, Percy O., Humphreys Corp., Mont Belvieu, Tex.....'31
Wood, Robert H., Broswood Oil Co., 430 Beacon Bldg., Tulsa, Okla.....'20
Wood, Virgil O., Broswood Oil Co., 430 Beacon Bldg., Tulsa, Okla.....'20
Woodford, Alfred O., Pomona College, Claremont, Calif.....'24
Woods, E. Hazen, Sinclair Prairie Oil Co., Box 1144, Midland, Tex.....'25
Woods, R. D., Humble Oil & Refg. Co., 1065 Humble Bldg., Houston, Tex.....'35
Woods, Sam H., Sun Oil Co., Box 1348, Tulsa, Okla.....'25
Woodward, Albert F., Box 67, Whittier, Calif.....'38
Woodward, George E., Jr., 2112 N. W. Twenty-fifth St., Oklahoma City, Okla....'29
Woodward, Harold Robinson, 401 S. Belmont Ave., Wichita, Kan.....'25
‖Woodward, T. P., Carter Oil Co., Box 1151, Seminole, Okla.....'39
‖Woodward, W. T., consulting, Security Bldg., Taft, Calif.....'38
Woolley, Glen C., Transwestern Oil Co., Wichita, Kan.....'28
Woolsey, E. V., consulting, Box 268, Luling, Tex.....'20
‖Word, Charles F., Box 1821, Midland, Tex.....'38
‖Word, McGehee, Navarro Oil Co., Box 1348, Alice, Tex.....'39
Workman, L. E., 602 W. Washington St., Urbana, Ill.....'40
Wosk, L. David, 1009 Subway Terminal Bldg., 417 S. Hill St., Los Angeles, Calif...'24
Wrather, W. E., consulting, 4300 Overhill Drive, Dallas, Tex.....'17
Wright, Andrew C., Shell Oil Co., Inc., Box 2037, Tyler, Tex.....'20
Wright, Fay Linton, consulting, 526½ N. Orange St., Glendale, Calif.....'27
Wright, Fred S., Box 1151, Midland, Tex.....'20
Wright, Harry F., consulting, 301 Philtower Bldg., Tulsa, Okla.....'19
Wright, Hugh, Texas Gulf Sulphur Co., 1009 Second Natl. Bank Bldg., Houston Tex.....'30
‖Wright, Randall, 1310 Crawford, Houston, Tex.....'35
‖Wright, Ray H., consulting, 218 Poplar St., Abilene, Tex.....'38
‖Wright, T. G., Stanolind Oil & Gas Co., 429 First Natl. Bank Bldg., Wichita, Kan..'40
Wyckoff, J. W., geological engineer, 2954 Oakwood Drive, E. Grand Rapids, Mich..'35
Wylie, James R., Jr., consulting, 1217 Grant Bldg., Pittsburgh, Pa.....'21
Wyman, Everett A., Amerada Petr. Corp., Box 2040, Tulsa, Okla.....'24
Wynn, Warren H., Sinclair Prairie Oil Co., Box 521, Tulsa, Okla.....'26
Wynne, H. C., 110 E. Vinita St., Sulphur, Okla.....'36
Wyszynski, O. W. T., Stonehaven Apts., 1523 N. McCadden, Hollywood, Calif....'39

Yager, Charles E., Texas Pacific Coal & Oil Co., 2300 Fort Worth Natl. Bank Bldg., Fort Worth, Tex. '24
‖Yarborough, Hunter, Jr., Box 352, Hattiesburg, Miss. '39
‖Yates, Harvey E., Box 397, Artesia, N. Mex. '36
‖Yenne, Keith A., Shell Oil Co., Inc., Box 476, Centralia, Ill. '41
Yoakam, Coler A., 2414 First Natl. Bldg., Oklahoma City, Okla. '22
‖Yoho, Herbert, R. D. 1, Box 193, Byesville, Ohio '40
Young, Addison, Landreth Prod. Corp., Box 792, Midland, Tex. '30
‖Young, C. T., 1711 Wentworth Ave., Houston, Tex. '27
Young, Jackson S., 237 Preston, Shreveport, La. '28
Young, Umberto, Republic Petr. Co., 811 W. Seventh St., Los Angeles, Calif. '28
Young, Wilber H., Jr., Empire Gas & Fuel Co., Wellsville, N. Y. '35
Youngmeyer, Ray, Amerada Petr. Corp., Box 2026, Tyler, Tex. '21
‖Yunck, George F., Pure Oil Co., Box 311, Olney, Ill. '39

Zaba, Joseph, Rio Bravo Oil Co., Houston, Tex. '33
‖Zadik, J. W., Baker Oil Tools, Inc., Box 4193, Oklahoma City, Okla. '39
Zavoico, Basil B., The Chase Natl. Bank, 18 Pine St., New York, N. Y. '25
Ziebold, William O., Spartan Gas Co., 518 Kanawha Valley Bldg., Charleston, W. Va. '29
Ziegler, F. M., Kern Oil Co., Ltd., Los Angeles, Calif. '39
Zimerman, Sam, Carter Oil Co., Box 270, Waurika, Okla. '31
Zimmerman, C. C., The Texas Co., Box 2332, Houston, Tex. '31
Zimmerman, James Z., consulting, Delmont, Pa. '22
‖Zinke, Ernest C., 1715 Avenue N, Galveston, Tex. '39
Zoller, Lawrence J., Central Commercial Co., Box 2306, Tulsa, Okla. '21
Zorichak, Joseph J., 1545 E. Thirty-fourth St., Tulsa, Okla. '24
Zuber, Stanislav, Hotel Boston, Rome, Italy '31
Zuloaga, Guillermo, Standard Oil Co. of Venezuela, Caracas, Venezuela, S. A. '37

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Poor, Russell S.
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TUSCALOOSA—Evans, Vincent
Rand, William W.
UNIVERSITY
Andrews, Thomas C.
Bowles, Edgar O.
Richards, Edward Franklin

ARIZONA

SCOTTSDALE
Jones, Edward L., Jr.

ARKANSAS

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Klinger, E. D.
McGuigan, F. H.
Montgomery, Don D.
FAYETTEVILLE—Giles, Albert W.
FOREMAN—Kerr, John B.
HEBER SPRINGS—Kirby, Louie C.
HUNTSVILLE—Scott, Horace L.
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Branner, George C.
Corbin, Milton W.
Hardy, William McC.
Monahan, Charles Joseph
MAGNOLIA
Copeland, Richard G.
Grubb, Carl F.
Hart, Raymond M.

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Booth, William Norfolk
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Bowles, Thomas K.
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Kilkenny, John E.
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King, Victor H.
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Kistler, Phillip S.
Kleinpell, William D.
Krammes, Kenneth F.
LeConte, Joseph
Ledingham, Glen W.
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Matjasic, Wallace L.
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McGovney, Paul E.
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Miller, Guy E.
Miller, Robert H.
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Taylor, Dewitt E.
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Weddle, Herman W.
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Winham, W. P.
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Hulin, Carlton D.
Lawson, Andrew C.

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Reed, Irvin John
Uren, Lester C.
Wilson, Ivan Franklin

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Pellekaan, W. Van Holst
Smith, Merritt B.
Sullwold, Harold H.

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COVINA—McNab, James

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Hughes, Donald D.
Pyle, Howard C.
Wright, Fay Linton

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Holland, Laurier F. S.
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Van Beveren, O. F.
Wyszynski, O. W. T.

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Dudley, Paul H.
Edwards, Merwin G.
Henquet, Roger
Natland, M. L.
Osborne, Lee S.
Park, Stafford
Poland, Joseph F.
Porter, John L.
Rothwell, W. Thomas
Stewart, Sam
Ten Eyck, Warren E.

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Bowes, Glenn H.
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Burtt, John G.
Canfield, Charles R.
Cassel, Chester
Chappius, Louis C.
Clark, Alexander
Clark, Harold J.
Clark, Robert W.
Clute, Walker S.
Collom, Roy E.
Comstock, William Sears
Corey, William Henry
Creasey, Saville Cyrus
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Cutler, Willard W., Jr.
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DeMaris, Elmer L.
Detrick, Dana F.
D'Evelyn, Morton N.
Dodge, John F.
Dodge, Theodore A.
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Durrell, Cordell
Earl, Glenn M.
Eaton, J. Edmund
Edwards, Everett C.
English, Walter A.
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Finnerty, Thomas J.
Fortine, Dwight H.
Fyfe, Douglas
Galliher, E. Wayne
Garber, Marshall West
Gardett, Peter H.
Gardiner, Chester M.
Gariepy, Glen Bernard
Geis, Wilfrid H.
Gentry, Albert William
Gilluly, James
Godde, H. A.
Goudkoff, Paul P.
Grant, U. S., IV
Greene, R. G.
Gregersen, Albert
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Haines, Richard B.
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Hamill, James M.
Hancock, Ray A.
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Hazzard, John C.
Hemmings, H.
Henny, Gerard
Hogan, Dana
Holston, Ashly S.
Hook, Joseph S.
Hoots, Harold W.
Hudson, Frank S.
Ickes, E. L.
Isberg, John T.
Jensen, Joseph
Johnson, Clifton W.
Johnson, Harry R.
Johnston, Elizabeth Jane
Johnston, Kenneth A.
Johnston, Norris
Kemnitzer, Luis E.
Kew, W. S. W.
King, Vernon L.
Kluth, Emil
Krueger, Max L.
Laiming, Boris G.
Lange, Robert William
Lee, Harvey W.
Lewis, Milton W.
Loel, Wayne
Long, Carl T.
Loofbourow, J. S., Jr.
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Macready, George A.
Maxson, John H.
McCloskey, Downs
McCollom, C. R.
McCollough, Edward H.
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Minshall, Francis E.
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Morgan, Frank A.
Myers, Desaix B.
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Rumsey, Nelson J.
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Smith, Hampton
Smith, Wayne M.
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Soyster, M. H.
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Steiny, Homer J.
Stewart, Irvine E.
Stipek, Raymond J.
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Ten Eyck, Richard
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Thornburgh, H. R.
Tieje, Arthur J.
Triplett, Richard L.
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Vallat, Eugene H.
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Vandiver, Vincent W.
Vedder, Dwight G.
Wagner, Carroll M.
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Waltman, W. D.
Waterfall, Louis N.
Watson, C. P.
Whealton, Rowland G.
Williams, George C.
Willis, Cornelius G.
Willis, Robin
Winterer, Edward V.
Wood, James T., Jr.
Wosk, L. David
Young, Umberto
Ziegler, F. M.

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MADERA—Junger, Arne

MANHATTAN BEACH
Meiville, A. G.

MCKITTRICK
Kleeman, Albert P.

MODESTO—Heggblom, J. Conrad

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Nichols, Norman M.

OAKLAND—Crook, Theo H.
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OILDALE—Cortright, William D.
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Manlove, Charles Francis
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Schenck, Hubert G.
Taff, Joseph A.
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Campbell, Ian
Gale, Hoyt Rodney
Gutenberg, Beno
Hoover, Herbert, Jr.
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McKanna, Edwin A.
Morris, Lawrence K.
Pratley, H. Hart
Riddell, Charles Edwin
Rupnik, John J.
Smith, Colin Hubbard
Vaughan, F. E.
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Douglas, James M.
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SAN FERNANDO
Kennett, William Eric
SAN FRANCISCO
Adams, Elmo W.
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Church, Clifford C.
Classen, Willard J.
Cranson, Lorin A.
Cunningham, George M.
Davies, Fred A.
Decius, L. Courtney
Gaylord, E. G.
Gester, George C.
Gester, Stephen H.
Hanna, G. Dallas
Hardy, Norman
Hawley, Henry J.
Henry, Leonard W.
Herrick, Henry N.
Hillis, Donuil L.
Jenkins, Olaf P.
Kerr, Richard C.
Kirby, James M.
Lebkicher, Roy
McFadden, William A., Jr.
Menken, Fred A.
Newbill, Thomas J., Jr.
Nomland, J. O.
Stalder, Walter
Stoner, R. C.
SAN GABRIEL—Bernt, Daniel M., Jr.
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Heathman, Walter W.
Merritt, Floyd C.
SAN MATEO
Klingaman, George L.
SANTA BARBARA—Baddley, E. R.
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Johnson, Curtis H.
MacDonald, Erwin H.
SANTA PAULA—Robertson, G. K.
Scott, Edward W.
Wedel, Arthur
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SONORA—Solari, Allison Jarvis
STANFORD UNIVERSITY
Blackwelder, Eliot
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Cerkel, J. David, Jr.
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Reynolds, Sargent M.
Simonson, Russell R.
Stipp, Thomas F.
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Travers, William J., Jr.
Turman, Arthur F.
Woodward, W. T.
VAN NUYS—Ford, W. E., Jr.
VENTURA—Beal, Carlton
Birkhauser, Max
Cross, Rodman K.
Dibblee, Thomas W.
Hertel, Francis W.
Leach, Claude E.
Ogier, E. H.
Rathwell, Harold B.
Sears, David Hume
Smith, Lyle W.
Stewart, R. E.
WASCO—Ballard, Gene
WHITTIER—Bemts, Harold C.
Bowen, Gilbert T.
Forrest, Lesh C.
Lynton, Edward D.
Woodward, Albert F.

COLORADO

BOULDER—Rohwer, F. W.
Thompson, Warren O.
COLORADO SPRINGS
Beardsley, William R.
Oborne, Harry W.
DENVER—Ames, Edward W.
Aurand, Harry A.
Bateman, A. F., Jr.
Blair, Robert W.
Blixt, John E.
Boos, C. Maynard
Brainerd, Arthur E.
Christensen, H. E.
Cullen, Albert William
Davies, Herman F.
Dobbin, Carroll E.
Erdmann, Charles E.
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Henderson, Charles W.
Hendrickson, Victor J.
Hickey, Harold N.
Holloman, Roy
Kramer, William B.
Lavington, Charles S.
Low, Julian W.
Manion, Clarence E.
McCready, Harry J.
McNulty, Joseph M.
Mellen, William P.
Miller, David B.
Rath, Charles M.
Rennie, Waldo E.
Shaw, Everett S.
Sherbondy, William Everett
Shoenfelt, C. E.
Sohlberg, R. G.
Stewart, Hugh A.
Wolters, Earl M.
Wood, J. Pendleton
ESTES PARK—Heaton, R. L.
GOLDEN—Heiland, Carl A.
Johnson, J. Harlan
Parker, Ben H.
Stevens, E. H.
Van Tuyl, Francis M.
Waldschmidt, W. A.
Wantland, Dart

CONNECTICUT

GREENWICH—Hinds, Henry
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Bateman, Alan M.
Schuchert, Charles
STAMFORD—Emendorfer, Earl
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White, Tell T.

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TAMPA—Campbell, Robert B.

GEORGIA

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Heshmati, Ali Ghoalie Khan

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Hager, Dorsey
Jensen, Frederick T.

Johnson, Walter
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Lester, John L.
Love, John David
McGhee, J. Rex
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Rankin, Horace Ellis
Robinson, Ernest Guy
Shakely, Ed
Simmons, Kenneth A.
Sinclair, W. B.
Taylor, George Ernest
Yenne, Keith A.

CHAMPAIGN—Walcher, Wayne E.

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Holden, Frederick T.
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Stevenson, Frank V.
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Turner, Jonathan Douglas

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LaPeire, George W.

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LAWRENCEVILLE
Poteet, James Harold

MARSHALL
Donnelly, Clarence W.
Konkel, Philip M.
Kurtz, Robert G.

MATTOON—Absher, K. B.
Anderson, Carl B.
Beck, Robert W.
Branson, E. R.
Chapman, R. T.
Chasey, Kenneth L.
Dana, P. L.
Fuller, Melville Weston
Grigsby, R. B.
Hicklin, Richard S.
Hirsch, Jack
Johnson, Elton D.
Jones, Verner
McCulloch, James Cole
McHugh, James W.
Melvin, Marlowe D.
Newton, William A.
Nuckolls, William Carlisle
Richards, Ben Howard
Ridgeway, Bertrand S.
Scobey, Ellis H.
Scott, Vernon C.
Selk, Erwin L.
Sellin, H. A.
Simonton, Owen W.
Staplin, Rex
Stratton, Everett F.

MCLEANSBORO—
Buehner, John Hubert

MT. CARMEL—Egan, Martin
Georgesen, Niels C.
Harris, D. B.

MT. VERNON—Brehm, Clarence E.
Fipps, E. L.
Folk, Stewart
Hoover, W. Farrin
Hunzicker, A. A.
Obering, Ernest A.
Smith, Julian W.
Whitney, Paul A.

NASHVILLE—Girdler, J. H.

OLNEY—Boling, Kenneth G.
Conger, Lauren Tenney
Cronin, K. Stewart
Fulton, Loris J.
Green, Darsie A.
Thurman, Franklin A.
Yunck, George F.

RIVER FOREST—Teas, L. P.

ROBINSON—Miller, W. Keith
Whittinghill, F. T., Jr.

ROCKFORD—Whitlock, R. A., Jr.

ST. ELMO—Potsch, John Peter
Randall, Duane C.

SALEM—Kneale, William C.
Thrasher, Glen C.

SPRINGFIELD—Noll, Don E.
Summerson, Charles H.

URBANA—Bell, Alfred H.
Carter, Charles William
Cohee, George V.
DeWolf, Frank W.
Hagan, Wallace W.
Hanes, Vincent Eugene
Leighton, Morris M.
Shepard, Francis P.
Sutton, A. H.
Townley, Enid
Wanless, Harold R.
Weller, J. Marvin
Winkler, Virgil
Workman, L. E.

VANDALIA
Wall, Thomas E.

INDIANA

ANDERSON—Reeves, James E.

BLOOMINGTON—Esarey, Ralph E.
Fanshawe, John R.
Fidlar, M. M.
Galloway, J. J.

EVANSVILLE
Barbour, Richard Morton
Bodkin, Hillard W.
Cahill, Edgar D.
Carman, Katharine W.
Cole, Edwin G.
Combs, Edward J.
Cooper, Russell C.
Dawson, Joseph M.
Edwards, Hall
Elder, Stanley G.
Engel, Noel W.
Everett, Rizer
Falletti, A. D.
Farrand, William Gardner
Forsyth, Roderick J.
Glass, Theodore G.
Gow, Kenneth L.
Hand, H. D.
Hard, Edward W.
Hoke, Charles J.
Honess, Charles W.
Horton, Harold M.
Keeler, William W.
Kornfeld, Sam
Latimer, F. Hubert
McClure, Perry S.
McEachin, W. D.
Nowlan, Harry H.
Osborne, Paul F.
Rogers, Maynard
Ross, Donald A.
Sackett, H. F.
Snider, George W.
Snyder, Raymond W.
Westmoreland, Earl
Whisenant, J. Barney

GREENCASTLE
Smith, Ernest Rice

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Calvert, Warren L.
Mundorf, T. Dean
Sprowls, Harlan A.

IOWA

AMES—Lonsdale, John T.

IOWA CITY—Miller, Arthur K.
Tester, Allen C.
Trowbridge, Arthur C.

MT. PLEASANT—
Smith, Marcus A. J.

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Bennett, Robert Turner

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KANSAS

BARNARD—Tucker, Paul M.

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Denman, C. E.
Knight, L. Clark
Lund, Wesley R.
McCullough, R. L.
McDaniel, Fred
Prescott, Gordon W.
Shannon, Sherril A.

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Stephenson, Eugene A.

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Walters, Ray A.

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TOPEKA—Allen, Devere F.

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Ainsworth, David
Allan, Thomas H.
Allen, Donald M.
Ashley, Burton E.
Barwick, John S.
Baughman, George W.
Bear, Melvern F.
Boreing, M. J.
Bowser, William F.
Bradish, Beverly B.
Bradley, Everett L.
Bruce, George H.
Buck, Loren I.
Butcher, S. D.
Carlson, Edwin N.
Carmody, Robert A.
Carpenter, E. Gail
Clark, Robert S.
Cole, Virgil B.
Conselman, Frank B.
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Copass, Jack M.
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Duerksen, Harold
Dunn, Burton C.
Edmiston, E. K.

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Folger, Anthony
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Garlough, J. L.
George, Robert Freeman
Girdler, Tom M., Jr.
Gutru, Robert J.
Hall, Roy H.
Hay, Lawrence
Heathman, Jack H.
Holl, F. G.
Holmes, S. W.
Howell, W. F.
Imbt, William C.
Inkster, John W.
Isaacs, Elizabeth
Jones, Charles T.
Kessler, L. W.
Koester, Edward A.
Lamb, R. C.
Larkin, J. J., Jr.
Larsh, Walter W.
Larson, Carl L., Jr.
Lee, Marvin
Lenahan, Tom
Marshall, John
Martin, Rudolf
McBee, William Dalton
McClellan, Hugh W.
McHugh, W. E.
McNeely, Robert B.
McNeil, Harold E.
Mettner, Francis E.
Meyer, Robert F.
Michaelson, Louis H.
Moncrief, E. C.
Morgan, L. C.
Morgan, L. G.
Norling, Donald L.
Norton, George H.
Oyster, Frank A.
Paddleford, Jack T.
Page, James H.
Philbrick, E. P.
Powers, Delmer L.
Pratt, Ernest S.
Putnam, George D.
Redmon, Harold E.
Reiserer, Victor F.
Roberts, Thomas N.
Roop, Charles W.
Russell, Harry J.
Sammons, George B.
Smedley, Harold O.
Smith, J. Peter
Speer, George W.
Stafford, Clare J.
Stucky, Zenas E.
Sullivan, Chris Rice
Talbott, W. G.
Taylor, Cyril B.
Ver Wiebe, Walter A.
Vickery, Ward R.
Webb, Rieman S.
Whortan, Raymond A.
Willson, Kenneth M.
Wimbish, Forrest E.
Wines, Donald Bradford
Winzeler, Alvin R.
Woodward, Harold Robinson
Woolley, Glen C.
Wright, T. G.

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Bailey, Joe E. L.

KENTUCKY

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Hunter, Coleman D.
Thomas, Ralph N.

GLASGOW—Preston, J. Basil

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Miles, Phil Middleton
Stith, Sam H.
Wilder, Newell M.

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Miller, Raymond
Shiarella, Nicholas W.
Wesley, George R.

PRESTONSBURG
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Hadley, Wade H.
Lock, John Henry
Romans, William A.
Shay, D. C.
Sprague, Robert D.

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Metts, Dean F.

DERIDDER—Iles, George, Jr.

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Kipp, E. M.

HOUMA—Babin, Logan H.
Bolyard, Garrett L.
Broughton, M. N.
Fanguy, Nolan A.
Ronbeck, Arthur C.

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Robichaux, Douglas B.

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Bingham, D. H.
Bornhauser, Max
David, Max
Ewing, Rudolph V.
Fry, Earl E.
Hagstette, Edgar J.
Marshall, Lester R.
Miller, Albert Douglas
Mills, Coe S.
Orchard, Paul Joseph
Pennel, H. David
Sands, Charles D.

LAKE CHARLES
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Burford, Selwyn O.
Canada, W. R.
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Henning, John L.
Hoskins, Baker, Jr.
Jennings, Philip H.
Mahoney, J. F.
McGlasson, H. E.
Roach, C. B.
Rukas, Justin M.
Tygrett, H. V.
Vincent, Mordelo, Jr.

MANY—Goebel, Lawrence A.

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Campbell, William R.
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Pierce, Harold Frederick

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Calahan, Luther Weldon
Ferrero, Clarence
McLendon, Dan Harvey
Shepherd, G. Frederick

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Bremer, Bernhard E.
Clement, George M.
Janovy, John
Goodwill, Donald, Jr.
Little, Sterling E.
Loeblich, Helen Tappan
Lytle, J. Edward
Moresi, Cyril K.
Petersen, Harluf C.
Petersen, M. O.
Schneider, G. W.
Seashore, Paul T.
Steinmayer, R. A.
Thaete, Edward H., Jr.

RUSTON—Laskey, G. E.

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Alexander, Clyde W.
Anderson, Tom A.
Aronson, Sam M.
Ashley, Richard M.
Bailey, Willard F.
Barret, William M.
Barton, Louis A.
Bay, Harry X.
Bell, Harry Wesley
Blanpied, B. W.
Borden, S. P.
Breedlove, Robert Leeroy
Cartwright, Weldon E.
Caster, E. L.
Chisholm, W. F.
Clark, Chester C.
Cochran, Phil K.
Cox, H. Mack
Crider, Albert F.
Crow, L. M.
Day, Clarence O.
Dennis, Wilbert C.
Eaves, Everett
Engleman, Rolf
Fischer, Victor N.
Flesh, David J.
Frazell, W. D.
Freed, Richard
Gill, J. Willard
Goldstein, August, Jr.
Grage, Victor P.
Green, George Gardiner
Hardin, V. A.
Harlowe, Leslie S.
Hazzard, Roy T.
Henson, G. R.
Howard, Douglas D.
Howard, George Carl
Hughes, Richard J., Jr.
Hutson, E. B.
Jackson, Alvin M.
Johnson, Holger Olin
Kamb, Hugo R.
Livingston, Noyes B.
Lloyd, Abe M.
Magale, John F.
Marshall, W. H
McFarland, L. R.
McKnight, C. R.
McLaren, Robert L.
Miller, E. Floyd
Minkofsky, Anna
Mix, Sidney E.
Monsour, Eli T.
Moody, Clarence L.
Moody, John D.
Packard, Sidney A.
Peterson, M. A.
Philpott, Thomas Hughes
Pike, William S., Jr.
Plaster, William M.
Purzer, Joseph
Robinson, Van D.
Safonov, Anatole
Schilling, Karl H.
Schwartz, Channing B.
Seals, Wilburn Hale
Shearer, Harold K.
Smith, Lloyd B.
Spears, Walter H.
Spofford, Howard N.
Spooner, W. C.
Stewart, Charles A.

Stiller, Ernest A.
Thomas, George Dewey
Totten, Robert Briggs
Vernon, Benton R.
Wallace, William Edwin, Jr.
Warren, R. F., Jr.
Weeks, Warren B.
Weintz, Clement A.
Whitwell, E. V.
Williams, John R.
Williamson, Harry
Wilson, Richard M.
Wiringa, Leon O.
Young, Jackson S.

SULPHUR—Dunlap, John C.
Farley, William Richard
Whatley, James M.

SULPHUR MINES—Kilian, Harry
May, George N.

UNIVERSITY
Chawner, William D.
Fisk, Harold N.
Granberry, Raymond J.
Howe, Henry V.
Huner, John, Jr.
Kaplan, Lazard Harold
Maher, John C.
Martin, James L., Jr.
McGuirt, James H.
Murray, Grover, Jr.
Roy, Chalmer J.
Russell, R. Dana
Russell, Richard Joel
Smith, R. Hendee
Stanley, Ben, Jr.
Wilbert, Louis J., Jr.

WINNFIELD—Payne, C. Winthrop
Stoker, Carl E.

MAINE

SKOWHEGAN—Smith, George Otis

MARYLAND

BALTIMORE—Dorsey, Geo. Edwin
Nance, J. B.
Singewald, Joseph T., Jr.

CUMBERLAND
Malamphy, Mark C.

MASSACHUSETTS

BOSTON—LaCroix, Morris F.

CAMBRIDGE—Beers, Roland F.
Lane, Alfred C.
Mather, Kirtley F.
Smith, Norman C.
Whitehead, W. L.

NORTHAMPTON
Shaub, Benjamin M.

SHARON—Cushman, Joseph A.

MICHIGAN

ALLEGAN—Nicola, Oliver P., Jr.

ANN ARBOR—Belknap, Ralph L.
Kellum, Lewis B.
Lovering, T. S.

CASSOPOLIS
Bishop, Margaret Stearns

GRAND RAPIDS—Given, Robert J.
Hunt, Raymond S.
Newcombe, Robert J. B.
Roberts, Richard L.
Smith, Robert Harlow
Whitney, Paul B.
Wyckoff, J. E.

GROSSE POINT
Keller, P. Hastings

JACKSON—Gentry, H. L.

LANSING—Buttermore, Paul M.
de Cousser, Kurt H.
Grant, Rex P.
Martin, Helen M.
Smith, Richard A.

MT. PLEASANT
Brown, William F.
Clark, William A.
Moses, Carl E.
Schulz, William M.
Sleight, Glenn C.
Thomas, George T.
Thomas, William A.

MIDLAND
Alquist, Francis Nelson

SAGINAW—Addison, Carl C.
Baltrusaitis, Edward Joseph
Clark, Charles K.
Ehlers, Allen
Kirkham, Virgil R. D.
Lamar, Lee C.
Maebius, Jed B.
Osgood, Manley, Jr.

SPRING LAKE—Boos, Edward J.

MINNESOTA

EVELETH—Neumann, Fred R.

MINNEAPOLIS
Donovan, Percy W.
Emmons, William H.
Hill, Robert Grant
Morgan, Ray E.
Stauffer, Clinton R.

MISSISSIPPI

COLUMBIA—Reed, Paul C.

FOREST—Owen, H. J.

HATTIESBURG
Houston, Sam H., Jr.
Maley, Vaughn C.
Munro, Donald J.
Yarborough, Hunter, Jr.

IUKA—Mellen, Frederic F.

MERIDIAN—Elliott, A. C.

JACKSON—Gaby, Edwin D.
Gawthrop, R. M.
Harbison, Robert R.
Harrell, David C.
Harris, R. Merrill
Henderson, John D.
Holston, A. A.
Hood, Forrest W.
Hughes, Urban B.
Jeffreys, Geoffrey
Kittredge, Frank R.
Lillibridge, Harry E.
McCoy, Joseph H.
McGlothlin, Tom
Michael, James F.
Morgan, Cecil L.
Neely, Joseph
Rea, Henry Carter
Seedle, Charles W.
Spooner, K. K.
Storey, Joseph B.
Talley, Gilbert A.
Toler, Henry N.
Watson, Robert N.
Wilcox, Stanley W.

MISSOURI

BOONVILLE
Redfield, Robert C.

COLUMBIA—Blackstone, D. L.
Branson, E. B.
Umbach, Paul H.

JOPLIN—Fowler, George M.

KANSAS CITY—Bartle, Glenn G.
Bassett, Charles F.
Burt, Roy A.
Smith, Rufus M.

ROLLA—Buehler, H. A.
Ellison, Samuel P., Jr.
Greene, Frank C.
McQueen, Henry S.
Noble, Gilbert W.

ST. JOSEPH—Cheyney, Alvin E.
Earl, Will F.
Matson, Thomas E.
Neiler, William Dixon
Potter, Nelson B.

ST. LOUIS—Bakke, W. E.
Buchner, Carl F.
Stearn, Noel H.
Wheeler, H. A.

TARKIO—Rogers, Andrew J.

MONTANA

BAKER—Munro, James H.

BILLINGS—Berg, Karl A. E.
Hageman, Donald E.

BUTTE—Feray, Dan Edwards

COLUMBUS—Grant, Paul A.

CUT BANK—Hupp, John Ervin
McCourt, James H.

HAVRE—Postle, Gordon L.

NYE—Broedel, Carl Huntington

NEBRASKA

FALLS CITY
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HOLDREGE—Bates, Charles C.
Ward, Dwight E.

LEIGH—Hunt, Leo Frank

LINCOLN—Lugn, A. L.
Reed, Eugene C.
Rogers, Wilbur F.
Schramm, E. F.
Thomas, Harold S.

OMAHA
Martin, John Charles, Jr.
Wegemann, Carroll H.

NEW JERSEY

ARLINGTON—Hoffer, Clarence W.

METUCHEN—Rhodes, Edward J.

MONTCLAIR
Leibensperger, Raymond

MOUNTAIN LAKES
Moulton, Gail F.

NEW BRUNSWICK—Crowl, G. H.
Hayes, Albert O.

PITMAN—Lupton, John H.

PRINCETON—Fox, Steven K.
Knight, J. Brookes
Mason, John F.
Maxwell, John Crawford
Sampson, Edward
Thom, W. T., Jr.

TENAFLY—Lilley, Ernest R.

NEW MEXICO

ALBUQUERQUE—Reiche, Parry

ARTESIA—Yates, Harvey E.

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Kraus, Edgar
Morgan, Robert Edward
Riggs, George D.
Wills, Neil H.

HOBBS—Davis, Roger H.
Gardner, Jack W.
Guinn, Delmar R.
Miller, Charles P.
Scott, Wilton E.
Staley, Glenn
Tanner, Hugh A.

JAL—Miller, Powell W.

PORTALES—Robbins, H. Weston

ROSWELL—Barnett, J. A.
Cave, Harold S.
Headley, Joseph B.

SANTA FE—Chase, William Lynn
Maxwell, Ross A.

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NEW YORK

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BRONXVILLE—Naramore, Chester

BUFFALO—Reeves, John R.

CANTON—Brown, Robert Wesley

GLOVERSVILLE—Olsson, Axel A.
ITHACA—Harris, Gilbert D.
Nevin, Charles M.
Palmer, Katherine V. W.
Ries, Heinrich
Waring, Gerald A.
POUGHKEEPSIE
Warthin, Aldred S., Jr.
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Baker, Raymond F.
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Bleecker, Edward S.
Bower, John O.
Brodie, Gerson H.
Brokaw, Albert D.
Brown, Barnum
Case, William B.
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Cobb, Margaret C.
Condit, D. Dale
Corbett, Clifton S.
Coryell, Horace N.
Cotner, Victor
Cox, Benjamin Burton
Crum, Harry E.
Davis, Robert J.
Dixon, A. Faison
Dresser, Myron A.
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Eagles, Homer M.
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Finch, John Wellington
Flagler, C. W.
Fuellhart, Donald E.
Garfias, Valentine R.
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Hamilton, Charles W.
Haynes, Winthrop P.
Herald, Frank A.
Heston, J. Ed
Hindes, E. P.
Holman, Eugene
Hubbard, Bela
Jablonski, E.
Kay, Fred H.
Kay, G. Marshall
Kinney, Harry D.
Knebel, G. Moses
Kraft, Philip
Lovejoy, John M.
McCulloch, Joseph P.
McKee, H. Harper
Miller, William Dana
Moore, Carl Allphin
Munoz, Robert R.
Newhouse, Lester
Olson, Walter S.
Paige, Sidney
Pertusio, Serge M.
Pogue, Joseph E.
Pratt, Wallace E.
Schmidt, Marion Roberta
Sealey, Fred C.
Skeels, Dorr Covell
St. Clair, Stuart
Stebinger, Eugene
Thomas, J. Elmer
Thompson, Lester S.
Tong, James A.
Townsend, R. M. F.
van der Linden, B. H.
Walters, Ray P.
Washburne, Chester W.
Wasson, Harold J.
Weeks, Lewis G.
Whiton, Herman F.
Zavoico, Basil B.
ROCHESTER—Gillette, Tracy
Grossman, William L.
Jameson, M. H.
Singewald, Quentin D.
SYRACUSE—Apfel, Earl T.
WELLSVILLE
Kreidler, William Lynn
Whorton, Chester D.
Young, Wilber H., Jr.

NORTH CAROLINA

CHAPEL HILL
McCampbell, John C.
Huddle, John Warfield
FORT BRAGG—Liming, John A.

NORTH DAKOTA

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Seager, O. A.

OHIO

BYESVILLE—Yoho, Herbert
CINCINNATI—Caster, Kenneth E.
Frink, John W.
Rich, John L.
Smith, Frederick James
CLEVELAND—Robinson, J. French
Smoots, John P.
CLIFTON—McCullough, A. S.
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Rehn, E. E.
Ring, Dewitt T.
Spieker, Edmund M.
FINDLAY—Donnell, James C.
Emery, Wilson B.
Funk, Fred J.
Koenig, Ralph A.
Walter, H. G.
LIMA—MacDonell, James A.
MEDINA—McCloy, Walter L., Jr.
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WARREN—Fugate, Ross James
YOUNGSTOWN—Farish, Linn M.
Moore, Fred H.

OKLAHOMA

ADA—Hatcher, Oscar
Jones, Boone
Laves, U. R.
Rixleben, Bruno
Witherspoon, Edgar
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Callahan, Drury V.
Clowe, Charles E.
Coleman, Tom L.
Edstrom, Donald E.
Fell, Harold B.
Gill, J. P.
Guthrey, W. Morris
Hancock, Bob
Milner, Charles A., Jr.
Neustadt, Walter, Jr.
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Westheimer, Jerome M.
White, Maynard P.
BARTLESVILLE
Absher, William F.
Allen, Harris Hayes
Ambrose, A. W.
Barclay, Stewart
Beck, A. F.
Burling, Lancaster D.
Charles, Homer H.
Clark, Clare M.
Clark, Robert P.
Courtier, William H.
Crawford, F. W.
Dietert, Arthur E.
Doan, R. L.
Elliott, George R.
Graham, B. L.
Hiestand, Thomas C.
Hintze, A. J.
Hoffman, Charles C.
Hoke, T. C.
Johnson, Lester H.
Jones, Daniel J.
Kidd, Robert L.
Knox, John K.
Kovac, M. Stephen
Lott, Frederick S.
Lounsbery, D. E.
Miller, Vincent
Morris, A. Ferd
Moss, Rycroft G.
Murphy, P. C.
Nisbet, John M.
Olson, Walter Sigfried
O'Keeffe, H. W.
Quesenbery, Alice M.
Reid, Robert P.
Riise, J. A., Jr.
Sands, J. M.
Shirk, Wilmer R.
Stirtz, W. Melvin
Thompson, Edwin I.
Tucker, R. H.
Weirich, T. E.
Wells, Murray J.
Wilhelm, Arthur K.
BOISE CITY—Morgan, Aubrey A.
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BROKEN ARROW—Harris, S. F.
CHANDLER—Wagner, J. Basil
CLEO SPRINGS—Herald, J. M.
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CUSHING—Ellison, Charles W.
DUNCAN—Allon, Michael
Gouin, Frank
Parsons, Claude P.
Smalley, Claire F.
EDMOND—Jones, Leland W.
ENID—Clifton, R. L.
Ford, Carl S.
Reeves, J. R.
Van Zant, James H.
GOTEBO—Bolar, Charles B.
HENRYETTA—Morris, Walter W.
HOBART—Russom, Vaughn W.
Stotler, Raymond T., Jr.
HOLDENVILLE
Shamblin, W. Earle
IDABEL—Couser, C. W.
JAY—Valerius, M. M.
LAWTON—Lea, Joseph William
MADILL—Brillhart, Norman W.
Northrip, Gerald Albert
MIAMI—Just, Evan
NASH—Wethington, William O.
NELSON—Bryan, Frank
NORMAN—Bednar, William Carr
Cloud, Wilbur F.
Decker, Charles E.
Dott, Robert H.
Frederickson, Edward A.
Gibson, George Drew
Gould, Charles N.
Harris, R. W.
Lalicker, Cecil Gordon
Mohler, C. Edwin
Monnett, V. E.
Oakes, Malcolm
Rudolph, Paul Jackson
Smith, Ralph E.
Thams, William H.
OILTON
Anderson, Oscar S., Jr.
OKEMAH—Geyer, Robert L.
Mowrer, Loren E.
OKLAHOMA CITY
Bale, Hubert E.
Ballard, William Norval
Brauchli, R. W.
Brown, H. Travis
Burress, George Howard
Buttram, Frank
Camp, Richard W.
Carpenter, M. E.
Casebeer, C. T.
Clark, William L.
Clinkscales, Albert S.
Conkling, R. A.
Danielson, G. Otis
Davis, Clyde E.

Earle, Francis, Jr.
Ellison, Kenneth A.
Faust, Josef
Frizzell, Mildred Armor
Gile, Richard E.
Hamilton, C. E.
Hicks, I. Curtis
Hoover, F. Mabry
Howard, Dan O.
Jones, Roy D.
Keeler, Clifton M.
Kite, William C.
Lapp, John H.
Laughbaum, Graydon H.
Laughlin, R. W.
Lees, Laurence F.
Lewis, William Dabney
Lynn, Robert H.
Marvin, Gaurd S.
McFarland, Earl R.
McGee, D. A.
McIntyre, George T.
Meland, Norman
Miller, Willard L.
Montgomery, A. J.
Moreman, Walter L.
Newby, Jerry B.
Norville, Glen S.
Ohern, D. W.
Patton, Roger R.
Perrine, Irving
Pollard, Robert T.
Ramsey, Charles E.
Richards, A. H.
Richards, J. T.
Sawyer, Roger W.
Schaeffer, Hugh C.
Schweer, Henry F.
Sears, Joseph M.
Shields, Fred C.
Singer, Alex
Smith, Gerald N.
Taylor, Charles H.
Turk, Lon B.
Turner, George R.
Van Dall, John E.
Whiting, Lester L.
Wooward, George E., Jr.
Yoakam, Coler A.
Zadik, J. W.

PONCA CITY
Athy, Lawrence F.
Boyd, W. Baxter
Clark, Glenn C.
Clark, Stuart K.
Graham, W. L.
Hunter, R. Lee
Maddox, Gerald C.
Mills, R. van A.
Morgan, D. M.
Mullinax, Jack D.
Parker, Everett C.
Prokesh, Hugh E.
Royds, James S.
Spain, David S.

PRAGUE—Klabzula, Robert E.

SAPULPA—MacKay, Hugh

SEMINOLE—Ackley, Kenneth A.
Hyatt, Don L.
Musselman, George A.
Nichols, P. B.
Willis, Clifford L.

SHAWNEE—Brown, Robert
Carpenter, Everett
Cassingham, Robert L.
Dawson, Edwin A.
DeLong, James A.
Ditsworth, Glenn William
Gahring, William R.
Goodman, P. W.
Hestbeck, Marion E.
Hill, V. G.
Hoyle, Charles R.
Hubley, Myron D.
Jenkins, Harold D.
Johnston, John C.
Kittredge, M. B.
Lehman, Roy P.
Meyer, Arthur M.
Muir, J. Lawrence
Quiett, Roy C.
Rau, Harold L.
Roberts, Gerald C.
Roberts, M. C.
Ruwwe, John W.
Spangler, Grant W.
Veeder, John A.

STILWELL—Hawes, Julian

SULPHUR—Fitts, John
Wynne, H. C.

TULSA—Ackers, A. L.
Adams, Kilburn E.
Allen, William Odis, Jr.
Arnold, Henry C.
Arnold, Lincoln Merchant
Bace, A. C.
Baldwin, Ben F.
Bartram, John G.
Bass, N. W.
Bates, R. P.
Becker, Dwight L.
Becker, Herman Carroll
Beekly, Albert L.
Bernard, W. E.
Berwald, W. B.
Bishop, F. L.
Bleakley, Alfred B.
Bloesch, Edward
Bohart, Philip H.
Borden, Joseph L.
Born, W. T.
Brant, Ralph A.
Brown, Harry J.
Brown, Merritt H.
Bryant, Howard S.
Buckstaff, Sherwood
Bullard, Edgar F.
Bunte, Arnold S.
Bush, Frederic A.
Butt, William H.
Carlson, Charles G.
Case, Leslie C.
Chapman, M. E.
Christenson, A. C.
Clark, Frank Rinker
Clark, Howard
Clark, L. W.
Claus, Clyde R.
Coffin, R. Clare
Conhaim, Howard J.
Cornelius, Lee Henri
Coryn, F. R.
Cullen, Ronald J.
Cumming, Alfred
Dannenberg, R. M.
Davis, Elliott
Davis, Leon V.
Davis, Sidney H.
Denison, A. R.
Desjardins, Louis H.
Dillard, W. Reese
Dille, Glenn Scott
Eckenwiler, Cleo W.
Egan, J. A.
Eirich, Constance G.
Elson, William H.
Emrick, D. G.
Faust, L. Y.
Feagin, Barney, Jr.
Ferguson, John L.
Finley, J. C.
Fitzgerald, Paul E.
Foley, Lyndon L.
Fosshage, E. W.
Gardner, James H.
Garrett, Robert E.
Gartner, James L.
Gilmour, Andrew
Giltinan, George Murray
Ginter, Roy L.
Gisburne, John Robert
Goodrich, Harold B.
Graeber, Clyde P.
Green, William G.
Griffith, Glenn R. V.
Griley, Horace L.
Hall, Dollie Radler
Hamilton, Irving Boyd
Hamilton, Robert G.
Hardison, George P.
Harlton, Bruce H.
Hawkins, Glenn D.
Heeren, Julius A.
Henry, W. W.
Hewett, Charles F.
Hill, Orval H.
Hoffman, Malvin G.
Hoover, James B.
Hopper, Walter E.
Horkey, William E.
Hosterman, John F.
Howard, W. V.
Howell, J. V.
Hudgens, Clyde O.
Hudson, Oscar M.
Hughes, Richard
Hull, J. P. D.
Hunt, Lenora May
Ingham, W. I.
Innes, Arland I.
Jenkins, Page T.
Johns, Wendell S.
Johnson, Edward W.
Kauffman, James S.
Kennedy, Luther E.
Kiess, Myron C.
Kimball, Kent K.
King, Charles C.
Kirk, Charles T.
Kister, Herbert H.
Kleen, Harold J.
Knappen, Russell S.
Kravis, Raymond F.
Kridler, George M.
Kyle, Jerry R.
Lambert, Gerald S.
Lane, C. W.
Lang, William J.
Larkin, Pierce
Leach, Thomas W.
Leatherock, Constance
Leatherock, Otto
Leiser, J. B.
Lester, O. C., Jr.
Levorsen, A. I.
Lilienberg, B. A.
Littlefield, Max S.
Lukert, Louis H.
Lyons, Paul L.
Markham, Edmond O.
Markley, Elmer A.
Mauck, Melvin Dwight
McCollum, Leonard F.
McCoy, Alex W.
McCrary, E. W.
McCutchin, John A.
McGirl, J. N.
McIntyre, Paul J.
McMillen, Raymond F.
Merritt, John W.
Milek, Andrew
Miller, B. Maxwell
Miller, Wendell Z.
Millikan, C. V.
Millison, Clark
Morero, Joseph E.
Morley, Harold T.
Mosburg, Lewis G.
Moses, Harold F.
Mossman, R. W.
Murphy, James K.
Murray, A. N.

Neal, E. Preston
Nelimark, John H.
Neumann, L. Murray
Newman, Thomas F.
Nufer, D. C.
Oliphant, A. G.
Peabody, Harlan W.
Peaker, Don H.
Phillips, Ross M.
Pishel, Max
Poirier, Otto A.
Price, James A.
Price, Sylvan S.
Probst, Karl Max
Rae, Colin C.
Redfield, John S.
Reisher, Paul H.
Reynolds, Karl W.
Richards, Raymond
Riggs, Robert J.
Riter, Samuel W.
Roark, E. L.
Roark, Louis
Roark, Louis Claude
Roark, R. B.
Ross, Charles M.
Russell, William L.
Rutledge, R. B.
Ryniker, Charles
Scott, H. M.
Scudder, E. W.
Seaman, L. O.
Sharpe, Joseph A.
Shea, E. F.
Sherry, William J.
Shutt, Roscoe E.
Simpson, Richard W., Jr.
Siverson, G. C.
Sloan, Raymond D.
Snow, Dale R.
Solliday, A. L.
Spahr, Marshall Richard
Stoner, O. E.
Strachan, Clyde G.
Stump, Mark E.
Tandy, J. Hiram
Tarr, Russell S.
Teis, Maurice R.
Templeton, James B.
Tillotson, Allen W.
Travis, Abe
Truex, Arthur F.
Upp, Jerry E.
Vernon, Jess
Wagner, Carl D.
Wagner, Cary R.
Wagner, Clyde L.
Wagoner, George E.
Wails, Elmer D.
Walker, Lucian H.
Wallace, P. A.
Watson, Joseph D.
Weatherby, B. B.
Weimer, Frank G.
Welch, Virgil H.
Wellman, Dean C.
Wells, Samuel W.
Westby, Gerald H.
White, Kirk S.
White, Luther H.
Willis, S. Morse
Wilshire, L. M.
Wilson, Walter B.
Wood, Robert H.
Wood, Virgil O.
Woods, Sam H.
Wright, Harry F.
Wyman, Everett A.
Wynn, Warren H.
Zoller, Lawrence J.
Zorichak, Joseph J.

WATONGA—Kolm, Paul H.
WAURIKA—Paterson, Robert
Zimerman, Sam

OREGON

PORTLAND—Williston, Samuel H.

PENNSYLVANIA

BRADFORD—Eckert, Frank E.
Fralich, Charles E.
Simmons, Arthur C.
CLARION—Arnold, H. H., Jr.
DELMONT—Zimmerman, James Z.
EASTON—Ward, Freeman
EDGEWOOD—Wilcox, Quentin L.
GERMANTOWN—Giles, John M.
MEADVILLE—Moody, Ray R.
OIL CITY
Montgomery, James G.
Secor, Donald T.
Seifert, Wilbur H.
PHILADELPHIA—Ellis, George L
Weeks, Herbert J.
PITTSBURGH—Allen, Frank T.
Backman, John E.
Bardeen, Thomas
Boots, Paul H.
Brankstone, Hugh R.
Bristley, L. P.
Bryan, Carl L.
Davis, Ralph E.
Drach, Gertrude M.
Dresbach, C. H.
Durham, James H.
Eckhardt, E. A.
Fettke, Charles R.
Folsom, L. W.
Foster, Alden W.
Galey, John Taylor
Gealy, Wendell B.
Gemmell, Howard F.
Gibbs, Harley S.
Goodman, John V.
Gulley, M. Gordon
Hastings, Wynne K.
Heald, K. C.
Hopkins, Richard H.
Kerbow, Russell B.
Lang, Ralph H.
Melchoir, Louis F.
Mortlock, Frank O.
Myers, LeMoyne W.
Nettleton, L. L.
Newlon, J. H.
Randall, Wendell P.
Rhoades, Ralph O.
Ross, Ralph B.
Schillhahn, E. O.
Shaffer, John M.
Sherrill, Richard E.
Somers, Ransom E.
Stephenson, Elizabeth E.
Tolmachoff, I. P.
Vance, W. R.
Watson, George R.
Wendenburg, Otto
Wylie, James R., Jr.
PLEASANTVILLE
Dickey, Parke A.
PORT ALLEGANY—Gaddess, Jack
Lockwood, R. P.
Walters, Mason G.
STATE COLLEGE
Pelto, Chester R.
Pirson, Sylvain J.
UPPER DARBY
Dickerson, Roy E.
WELLSBORO—Van Gilder, H. R.

SOUTH CAROLINA

PATRICK—Buie, Bennett Frank

SOUTH DAKOTA

RAPID CITY—Tullis, Edward L.
VERMILION—Rothrock, E. P.

TENNESSEE

COLUMBIA—Butters, Roy M.
KNOXVILLE—Hall, George M.
Parhiala, Leimo I.
NASHVILLE—Born, Kendall E.
Glenn, L. C.
Wilson, Charles W., Jr.

TEXAS

ABILENE—Byram, John P.
Haase, Fred M.
Hall, Ellis A.
Maxwell, Riley G.
Merry, Edward T.
Nowels, Kenneth B.
Perini, Vincent C., Jr.
Stall, Trovall Lafayette
Wright, Ray H.
ALBANY—Stasney, H. R.
ALICE—Blanchard, Stanley W.
Blouin, Cecil F.
Cooper, Robert P.
Davidson, J. P.
Scrafford, John Bruce
Short, Richard T.
Uri, Joseph John
Word, McGehee
AMARILLO—Anderson, Carl C.
Armstrong, Earle N.
Craig, T. C.
Devin, Fred A.
Giddings, H.
Hagy, Lawrence R.
Hemsell, Clenon C.
Henderson, W. D.
Hoover, William B.
Hughes, C. Don
Kautz, Archie R.
Mohler, Donald P.
Oles, L. M.
Paschal, Elisha A.
Peterson, Clarence J.
Powers, Elliot H.
Rogatz, Henry
Rumsey, Edward W.
Rusk, Willard W.
Thompson, James D., Jr.
Tichy, James R.
ARLINGTON—Lynch, S. A.
ARP—Thomas, William T.
AUSTIN—Barry, Gail A.
Bescher, Earl, Jr.
Bramlette, William A.
Bullard, Fred M.
Bybee, Hal P.
Bybee, Halbert Homer
Byram, R. W.
Cuyler, Robert H.
Damon, H. Gordon
Davis, Horace G.
Eifler, Gus Kearney, Jr.
George, W. O.
Hendricks, Leo
Matthews, Charles L.
Parker, Travis J.
Plummer, F. B.
Power, Harry H.
Sellards, E. H.
Snider, L. C.
Stenzel, Henryk B.
Teagle, John
Tuck, Louis L.
Weeks, Albert W.
Whitney, F. L.
Winkler, Hans
BAY CITY—Fryou, Joe A.
BEAUMONT—Bartlett, C. Lothrop
Braugh, Donald D.
Claypool, C. B.
Cook, E. E.
Denton, Harold
Durgan, Herbert L.
Justice, Philip S.
LaTouche, John D.

Pack, R. W.
Patton, Jacob L.
Rose, Harrison W.
Schroeder, Kingsley V.

BEEVILLE—Barnett, D. G.
Meltzer, Lee Hillard
Miller, David M.
Powell, Ezra H.
Shayes, Fred P.

BELLAIRE—Gardner, Edgar J.

BIG SPRING—Barnes, Chester F.

BORGER—Van Sant, John S.

BRECKENRIDGE—English, Leon E.

BRENHAM—Ferguson, W. B.

BROWNFIELD
Evans, David Morgan
Ferguson, Carlos M.

BRYAN—Vance, Harold

CAMERON—Robinson, B. F.

COLEMAN—Anderson, Robert G.
Cheney, M. G.
Jordan, Louise

COLLEGE STATION
Bacon, Charles S., Jr.
Gross, Henry Emmett
Roberts, Charles V., Jr.
Smith, J. Fred, Jr.
Toulmin, Lyman, Jr.
Turner, Francis Earl

COLUMBIA—Teague, J. U.

CORPUS CHRISTI
Alagood, Robert H.
Ballard, James L.
Beilharz, Carl F.
Benish, Robert L.
Benke, Roy
Benson, Dale L.
Bong, Carl P.
Booth, Robert T.
Briggs, Robert C., Jr.
Buck, Cleo Eugene
Camp, John F., Jr.
Cardwell, William Henry
Clark, J. Tate
Cole, Adna Malone
Cunningham, Carleton J.
Davies, Jack W.
Day, Willard L.
Ferguson, M. L.
Fisher, Dunbar A.
Gaenslen, George
Gierhart, Guy B.
Hagan, Arthur M.
Hancock, J. M.
Hansell, James M.
Heaton, A. H.
Herring, L. B.
Isenberger, N. P.
Jolley, Durward N.
Langton, Claude M.
Leonard, Clarence Z.
Loehr, Harry C., Jr.
Maley, W. A.
McCallum, Henry D.
Miller, Carroll C.
Nelson, Raymond T.
Newell, Donald F.
Owens, Frith C.
Parrish, Gaston H.
Poole, John C.
Pressler, Edward D.
Price, W. Armstrong
Reid, William McC.
Ries, Minette
Seevers, Harris N.
Stein, Ira H.
Storm, Lynn W.
Swiger, Rual B.
Taegel, Edwin A.
Tucker, Reagan
Voigt, Harold E.
West, Lloyd G.
Wood, Owen Bishop

CORSICANA—Bocock, Oscar L.
McGlothlin, William C.

COTULLA—Pawley, Julian K.

CUERO—Dexter, Laurence N.
Neer, Carl J.

DALLAS—Albritton, Claude C., Jr.
Allen, E. G.
Anderson, George H.
Bartell, Laurence D.
Beck, Elfred
Bostick, J. Wallace
Bright, Richard T.
Brooks, Olin D.
Brown, Augustus Bart
Burchard, Frederic L.
Burgess, V. N.
Burress, Walter M.
Byrd, David Harold
Carpenter, Charles B.
Carter, Devere V.
Cesinger, E. F.
Clark, John W.
Clawson, William W.
Collingwood, D. M.
Collins, C. Philip
Cortes, Henry C.
Cox, Harris
Crawford, David J.
DeGolyer, E.
Deputy, P. R.
Doering, John
Dunlap, George E.
Ekholm, Victor E.
Esunas, Bernard Joseph
Fisher, Barney
Fosdick, Arthur R.
Frost, Jack
Garner, Aubrey H.
Garrett, Melvin M.
Germany, E. B.
Gray, Alfred
Green, Cecil H.
Guthrie, Robert K.
Hager, Dilworth S.
Hammill, Chester A.
Headington, Clare W.
Heath, Francis E.
Hill, Harry B.
Hill, Robert T.
Jamison, Maurine H.
Jamison, Paul H., Jr.
Joekel, Fred E.
Karcher, John C.
Kelsey, Lewis O.
Kelsey, Martin
Kendrick, Frank E.
Knox, T. K.
Lahee, Frederic H.
Lewis, James A.
Love, Perry R.
Luman, Edmondson D.
MacNaughton, Lewis W.
Mayfield, Gid C.
McCoy, George Y.
McDermott, Eugene
McFarland, Paul W.
McFarland, R. S.
McGhee, George C.
McLeod, Angus
Menefee, James C.
Meredith, Carlton
Meyer, Willis G.
Monsour, Emil
Morgan, Charles Gill
Morgan, Henry J., Jr.
Nash, Paul E.
Newton, William W.
Oldham, Albert E.
Pernell, James Herbert
Pittman, C. V. A.
Pollard, Jack C.
Ralston, Wallace
Ransone, William Robert
Reagor, Edward C.
Rettger, Robert E.
Rider, Charles R.
Robinson, Heath M.
Rouse, John T.
Russ, Leon F.
Russell, P. G.
Sale, Clarence M.
Schultz, Frank August
Schwarz, Melbert E.
Sclater, Kenneth C.
Seale, Robert I.
Sherwin, M. W.
Shuler, Ellis W.
Simkins, J. J.
Smith, Eugene W.
Somers, George B.
Stehr, Raymond A.
Swesnik, Robert Malcolm
Tapper, Wilfred B.
Thompson, Sheridan A.
Toomey, Eugene J.
Tripp, R. Maurice
Walton, O. E.
Warren, John Edwin
Waters, James A.
White, Rex H.
Williams, Charles C.
Wilson, E. E.
Wilson, Joseph M.
Wilson, Malcolm E.
Womack, Brame
Wrather, W. E.

DENTON—Edson, Fanny C.

DENVER CITY—Gude, Leo J.

DONNA—Huntley, Louis G.

EAGLE—Moir, John

EASTLAND—Perkins, Joseph M.
Rank, R. A.
Steel, Robert J.

EDINBURG—Curry, Robert Bruce
North, Lloyd

EDNA—Ervin, Lynn D.

ELECTRA—Sheldon, Wichita F.

EL PASO—Irwin, Carl B.
Millard, William J.

FORT BLISS—Cross, Charles M.

FORT STOCKTON
Samuell, John Howard

FORT WORTH—Abbott, John L.
Adkisson, Albert
Allen, Alton C.
Applin, Paul L.
Aurin, Fritz L.
Bass, Perry R.
Bennett, Ethel Evans
Benton, L. B.
Berger, Walter R.
Bradfield, Herbert H.
Bradish, Ford
Brockway, E. R.
Brown, J. Earle
Canon, Joe
Casteel, S. H.
Christie, Robert S.
Christner, D. D.
Clark, G. C.
Clark, H. Smith
Cordry, C. D.
Cummins, R. H.
Dean, D. P.
Dean, P. C.
Donoghue, David
Fash, Ralph H.
Ferebee, D. M.
Freedman, L. H.
Fuqua, H. B.
Goodrich, Robert D.
Gray, Donald A.
Harris, Sidon
Hilseweck, William J.
Hudson, William A.
Hyde, Clarence E.
Imbt, Robert F.
Johnston, Lois L.
Kennedy, J. B.

Lee, Lynn K.
Lovejoy, J. B.
Lozo, Frank E., Jr.
Markley, Joseph H.
Marshall, F. E.
Maverick, Phillip
McCaskey, Morgan E.
McClure, Harold Y.
McCune, Paul
Melzer, Laurence S.
Mills, Lloyd C.
Mohr, C. L.
Morris, James L.
Mygdal, Karl A.
Nicol, David
Nolte, William J.
Pilcher, Ben L.
Poulsen, Frank E.
Powell, Ralph S.
Reeves, Frank W.
Renaud, Charles L.
Reynolds, Roy A.
Romine, Thomas B.
Schouten, Franklin H.
Schweers, Richard Henry
Scott, Gayle
Snebold, William F.
Stookey, D. G.
Taylor, Garvin L.
Thompson, B. E.
Thompson, R. R.
Upson, M. E.
Weaver, George A.
Wilson, John H.
Winton, Will M.
Yager, Charles E.

FREER—Tyler, H. Johnson
Wilson, F. Wayne

GAINESVILLE
Holland, Richard M., Jr.

GALVESTON—Zinke, Ernest C.

GROESBECK—Whitcomb, Bruce

HEBBRONVILLE—Ely, George N.

HENRIETTA
Hunzicker, Vernon J.

HONDO—Brucks, E. W.

HOUSTON—Adams, Frank C.
Adams, W. C.
Adkins, W. S.
Adler, Joseph L.
Akkerman, Richard Pete
Albertson, Maurice M.
Allen, Stanley R.
Allison, A. P.
Anderson, John G.
Andrau, E. W. K.
Andrews, W. W.
Archie, Gustave E.
Artusy, Ray
Augenthaler, Robert L.
Back, Denys H.
Bader, G. E.
Bailey, Thomas L.
Baker, William A., Jr.
Baldwin, E. B.
Banta, H. E.
Barragy, Edward J.
Barrow, Leonidas T.
Bauernschmidt, A. J.
Beatty, Robert M.
Beckelhymer, Roy L.
Becker, Raymond C.
Bell, Douglas E.
Bell, Olin G.
Belt, Ben C.
Bennett, Malcolm D., Jr.
Benson, Don G.
Berg, Gilman A.
Best, J. Boyd
Black, Jo Pat
Blackburn, Willis C.
Blanchard, W. Grant
Blau, Ludwig W.
Bleyberg, Arnold
Bolinger, John W.
Boone, Dan E.
Born, Howard R.
Bowles, R. C.
Bowling, Leslie
Bowman, Wayne F.
Boyles, James M.
Brace, Orval L.
Braunstein, Jules
Briard, Vernon E.
Bricker, John F.
Brokaw, John M., Jr.
Broussard, David F.
Broussard, Lloyd J.
Brown, Samuel B.
Bruyere, Alan
Buchanan, George S.
Buck, E. O.
Bugbee, J. M.
Bunsen, A. W.
Burchfiel, Hugh L.
Burke, James D.
Burkhead, W. Z.
Byers, J. W.
Calohan, William F.
Campbell, F. F.
Campbell, J. L. P.
Cantrell, Ralph B.
Carey, Hillard W.
Carlton, Dave P.
Carr, George W.
Cartwright, Lon D.
Casey, S. Russell
Cashin, D'Arcy M.
Chambers, Jack
Charrin, P.
Childerhose, Allen J.
Christie, Laurence G.
Church, Charles R., Jr.
Clark, Everett Harden
Clark, George H.
Clark, William A., Jr.
Clark, W. Kenley
Clifford, O. C., Jr.
Cogen, William M.
Colle, Jack Overton
Collett, J. Daviss, Jr.
Conrad, Charles S.
Conway, W. P., Jr.
Copeland, Robert R., Jr.
Crandall, Kenneth H.
Crowell, John H.
Cruce, John S., Jr.
Culbertson, J. Archer
Dake, Laurence F.
Davis, Donald M.
Davis, Flavy Eugene
Davis, Morgan J.
Decker, LaVerne
Deming, J. H.
Deussen, Alexander
Dissinger, Earl
Doherty, W. T.
Dorr, James B.
Durham, Charles A.
Durkee, Robert R.
Earl, Eugene L.
Eberle, Robert F.
Eby, J. Brian
Edson, Dwight J.
Elliott, J. E.
Ellis, Albert D., Jr.
Ellisor, Alva C.
Engle, Max D.
Esgen, W. K.
Evans, Frank G.
Evans, Noel
Fahle, Paul B.
Fenn, Ivan J.
Ferguson, Hershal C.
Ferrando, A.
Flowers, Jack
Flude, John W.
Fly, Paul J.
Fohs, F. Julius
Fouts, J. M., Jr.
Franklin, Louis
Franks, Robert M.
Fritts, Harold M.
Frost, Jay Miles, III
Funkhouser, E. M.
Fuqua, Marjorie
Gahagan, Donald I.
Galbraith, T. J.
Gale, Arthur S., Jr.
Galloway, Alan J.
Gardner, Frank Johnson
Garrett, J. B.
Garrett, Lovic P.
Getzendaner, A. E.
Gimbrede, Louis DeA.
Goerner, Fred S.
Golden, John M.
Goldston, Walter L., Jr.
Goldstone, Frank
Goodrich, Paul K.
Goodrich, Raymond H.
Gordon, Dugald
Gorman, William A.
Gray, Shapleigh G.
Gray, William D.
Grinsfelder, Sam
Guseman, L. F.
Guyod, Hubert
Hafner, W.
Hagen, Cecil Vernon
Hager, Lee
Halbouty, M. T.
Hall, Thomas O.
Halsted, Morris E.
Hamilton, Edward A.
Hamm, W. Dow
Hamman, John, Jr.
Hancock, William T., Jr.
Hanna, Marcus A.
Hansard, Charles O., Jr.
Hansen, Malcolm B.
Hardison, Harvey
Harkins, T. I.
Hartley, Burton
Harvey, Castle J. C.
Hasselmann, Karl F.
Hedley, J. David
Hendrickson, Robert D.
Hensch, C. R.
Herold, C. Lathrop
Heroy, William B.
Higgs, Morton T.
Hinson, Hillord
Hoard, J. O.
Hodder, Roland F.
Hoover, J. W.
Hornberger, Joseph, Jr.
Horner, William L.
Horvitz, Leo
Housh, C. N.
Hoyt, William V.
Huffmyer, Jack Roach
Hughes, Darrell S.
Hunter, Paul B.
Hussey, Keith M.
Hutchinson, Frederick M.
Igau, Hubert C.
Ingham, A. I.
Israelsky, Merle C.
Ivy, John Smith
Jackson, J. R.
Jay, Stanley E.
Jenny, W. P.
Johnson, Samuel C.
Jones, Robert L.
Jones, Wayne V.
Judson, Sidney A.
Jung, Dorothy A.
Kelly, John S.
Kemp, H. S.
Kennedy, Gilbert R.
Kerlin, M. L., Jr.

Kirk, Kathleen
Kisling, James W., Jr.
Kornfeld, M. M.
Ladner, A. L.
Lake, Charles L.
Lake, James L., Jr.
Lancaster, L. Kenneth
LaRue, James E.
LaRue, Wilton W.
Lasky, Bernard H.
Lay, Roy L.
Leavenworth, Paul B.
Leonardon, E. G.
Levy, David Jacob
Lewis, Ray C.
Lieb, Victor E.
Lowman, Shepard W.
Lucky, M. C.
Lund, Gage V.
Lyons, Richard T.
Mackay, Donald K.
Madera, R. F.
Malkin, Doris S.
Manes, O. B.
Marr, John D.
Martyn, Phil F.
Mason, Charles C.
Mason, Shirley L.
Mathes, Donald E.
McCarter, W. Blair
McDonald, H. W.
McFerron, George I.
McGowan, F. H.
McLellan, Hiram J.
McMillan, Joseph M.
McReynolds, Gregg F.
Mebane, Robert Duff
Metcalf, Roy J.
Meyers, P. A.
Michaux, Frank W.
Miller, Forrest J.
Miller, John C.
Milton, W. B., Jr.
Minor, H. E.
Mitchell, George D., Jr.
Mitchell, Harold D.
Mitchell, Robert B.
Montgomery, James C.
Moore, Homer C.
Moore, William B.
Mornhinveg, A. R.
Morris, Louis H.
Morrison, T. E.
Morse, Roy R.
Mower, Lowell K.
Mueller, Frederick W.
Murchison, Eugene A.
Myers, John C.
Myers, Julian Q.
Nance, A. G.
Neill, Wenzel B.
Nelson, Floyd A.
Niven, Robert N.
Noble, Homer A.
O'Bannon, Prentice H.
O'Donnell, Lawrence
Olcott, David Perry
Orynski, Leonard W.
Osterhoudt, Walter J.
Owen, Kenneth Dale
Parker, W. G.
Patrick, Walden W.
Paxson, Roland B.
Payne, Willard M.
Peacock, Henry Bates
Porter, Phil
Powless, R. C.
Pyeatt, Lloyd M.
Rainwater, Edward H.
Ray, Robert H.
Reasoner, M. A.
Reed, Edwin M.
Reedy, M. Frank, Jr.
Reese, Donald M.
Reiter, Wilhelm A.
Reynolds, F. F.
Richardson, Carl B.
Richardson, H. T.
Roberts, Dwight C.
Roberts, Louis C., Jr.
Rogers, James K.
Rolshausen, F. W.
Roper, Frank C.
Rosaire, Carol G.
Rosaire, E. E.
Rosenkrans, Robert Russell
Rose, Nicholas A.
Ross, E. McIver, Jr.
Runion, Felix A.
Russell, C. A.
Ryan, Reginald G.
Sample, Charles Hurst
Sanders, C. W., Jr.
Sappington, Chester
Sartain, Max R.
Saville, Wilson G.
Sawtelle, George
Say, Stanley R.
Schafer, Sidney
Schmidt, Karl A.
Scholl, Louis A., Jr.
Schumacher, J. P.
Schwennesen, Alvin T.
Scruggs, M. Dale
Selig, A. L.
Seren, Gordon W.
Sheets, Martin M.
Sherar, Edgar Smith
Sherar, Stuart
Simmons, Benjamin Titus
Sisson, Harry Hensel
Smiser, Jerome S.
Smith, A. E.
Smith, Aylwin L.
Smith, Erwin W.
Smith, Fred E.
Smith, Fred Lewis, Jr.
Smith, Gerald J.
Smith, Neal J.
Sorenson, I. L.
Speed, C. D., Jr.
Spoor, Harry C., Jr.
St. Germain, R. J.
Stamey, Roderick A.
Steig, Maynard H.
Steinberger, Clark R.
Stephenson, Morton B.
Stevens, George D.
Stewart, Charles H.
Stiles, Elisabeth
Still, J. T.
Stoddard, Gail H.
Stone, George Bailey
Stuckey, Charles W., Jr.
Suman, John R.
Sundt, O. F.
Sutton, Chase E.
Swigart, T. E.
Tash, George E.
Tatum, Emmett P.
Taylor, Josiah
Taylor, W. Harlan
Teten, R. P.
Thomas, James W.
Thompson, Evan G.
Thompson, John P.
Thompson, Wallace C.
Thomsen, Erik
Todd, John D.
Torrey, Paul D.
Trager, H. Arnold
Troxell, John N.
Tyson, Alfred K.
Uhrig, Leonard F.
Urbom, Oscar William
Van Burgh, Lisle R.
Van Eaton, Raymond A.
Van Melle, F. A.
Van Weelden, A.
Vaudoit, Paul L.
Vesely, Leon R.
Vetter, John M.
Vieaux, Don G.
Von Eiff, Herbert C. W.
Wade, Wallace Lee
Walker, Jules Hargis
Wall, Earle R.
Wallace, Davis M.
Ward, Roderick C.
Warner, Charles A.
Warren, Howard C.
Weatherston, Douglas
Weaver, Paul
Weingartner, R. A.
Welsh, Leroy G.
Wender, W. G.
Westmoreland, Frank S.
White, Dan J., Jr.
White, Gordon H.
White, James G.
Williams, Herbert E.
Wilson, Arthur Noble
Wilson, Ernest B.
Wolf, Albert G.
Woods, R. D.
Wright, Hugh
Wright, Randall
Young, C. T.
Zaba, Joseph
Zimmerman, C. C.

HUNTSVILLE—Metcalf, Myron C.

IRAAN—Crosby, George E.
Gregory, Peter Paul

KILGORE—Montgomery, Phil C.

KINGSVILLE—Dismukes, J. S.
Grosjean, Robert
Samford, Finis Mack
Sargent, E. C.
Williams, Carroll L.

LAREDO—Campbell, John M.
Drindak, Joseph Thomas
Fletcher, Claude Osborne
Johnston, Harry W.
Orr, Milo M.

LOCKHART—Lincoln, W. W.

LUBBOCK—Crider, Lewis C.
Dunn, David A.
Elkins, Campbell H.
Gibson, Donald Thomas
Klaus, Hellmut
Lyle, William E., Jr.
Patton, Leroy T.
Robinson, W. I.
Sidwell, Raymond
Stainbrook, Merrill A.
Teas, Paul C.

LULING—Woolsey, E. V.

MARATHON—Wilson, Homer M.

MARSHALL
Hammonds, G. Scott

MASON
McCammon, John H., Jr.

McALLEN—Hervey, O. S.
Jones, John Percy
Marston, R. L.
Minton, Joseph W.
Monk, John C.
Nichols, C. R.
Parker, Jack A.
Robinson, Cecil D.
Russo, Martin
Smith, Lee C.
Sparenberg, G. R.
Warner, J. Laird

MERCEDES—Coel, E. J.

MIDLAND—Abell, George T.
Allen, William Hammond
Anderson, W. D.
Armstrong, J. M.
Bailey, John J.
Bartley, Jerald Howard
Bayer, H. M.

Bingman, Neal J.
Brasted, Fred, Jr.
Brock, Stephen W., Jr.
Brown, Prentice F.
Bucher, J. Eric
Butcher, Cary P.
Carsey, J. Ben
Carter, G. R.
Champion, Oscar R.
Chase, C. Louis
Clarke, Robert L.
Clarkson, William George
Coil, Fay
Cole, Charles Taylor
Conkling, Russell C.
Conley, J. N.
Cooley, Ralph S.
Corey, George Simpson
Corman, Hyman
Coryell, Lewis S.
Cox, Robert T.
Crays, Glenn E.
Crump, John R.
Day, James R.
DeFord, Ronald K.
Dennis, Lyman Clark
Dickey, Robert I.
Donnelly, Alden Stuart
Dougherty, W. E.
Eley, Hugh M.
Farmer, Russell
Ferguson, Kenneth S.
FitzGerald, James, Jr.
Forgeron, Harold S.
Fritz, William Clayton
Funk, Marion H.
Giesey, S. C.
Green, Charles C., Jr.
Griswold, E. H.
Haigh, Berte R.
Harper, O. C.
Hartwell, Moreland T.
Haseltine, W. Lloyd
Hedrick, O. F.
Heid, Gordon W.
Hemphill, Herbert A.
Herd, John Harvey
Herold, John S.
Hills, John M.
Hitchcock, Edmund S.
Hyde, Ben Cooper
Irwin, Wallace W.
Kennedy, Joseph B., Jr.
King, Robert E.
Kinkel, W. C.
Kotyza, Fred F.
Lewis, Frank E.
Lloyd, E. Russell
Loskamp, Alvin P.
Mann, Robert S.
Martin, B. G.
McKay, A. E.
McKinsey, M. H.
Mix, C. A.
Moore, John I.
Moore, Prentiss D.
Moorhead, Johnny
Moxey, Walter G.
Oliver, Donald M.
Osborn, William M.
Parker, T. R.
Porterfield, R. R.
Ray, Bernerd A.
Reed, Edward Looman
Reigle, Edward E.
Roberts, Morgan E.
Rogers, Victor W.
Russell, Hewlett A.
Schlosser, Paul A.
Schneider, William T.
Secor, Dana M.
Simmons, Jesse A.
Skinner, John Wesley
Spencer, Maria
Taylor, Surce John
Teichman, Joseph B.
Tennis, Langdon C.
Terrill, J. V.
Thomas, Leonard C.
Tompkins, Joseph D.
Vanderpool, Eugene W.
Vertrees, Charles D.
Wade, R. T.
Wahlstrom, Edwin A.
Wallace, Louis S.
Ward, C. J.
West, W. W.
White, Richard D.
Wilcox, Fred H.
Winter, Niles B.
Woods, E. Hazen
Word, Charles F.
Wright, Fred S.
Young, Addison

MEXIA—Liddle, Ralph A.
MT. BELVIEU—Chun, H. A.
Woods, Percy O.
MT. PLEASANT—Webb, James A.
ODESSA—Boring, M. O., Jr.
Clark, Frank T.
OLNEY—Hauptman, Herman R.
OVERTON—Maxwell, Curtis F.
OZONA—Park, Noel R.
PUDACAH—Deuth, Martin J.
PAMPA—Blanchard, Frank N.
Phipps, J. B., Jr.
Rogers, Jesse A.
Schwartz, H. E.
PHILLIPS—Ribble, John M
PITTSBURG
Vanderpool, Harold C.
RIVERSIDE—Weinzierl, John F.
PLANO—Chaddick, W. M., Jr.
ROBSTOWN—Senseman, R. B.
ROSENBERG—Scrogin, John M.
Ustynik, Edwin F.
SAN ANGELO—Cannon, Joe
Cannon, R. L.
Cottingham, Virgil E.
Dodson, Floyd C.
Emch, John W.
Gregory, J. N.
Morgan, George D.
Ott, Emil
Ray, W. C.
Simpson, Roscoe M.
SAN ANTONIO—Achning, Walter J.
Alcorn, A. H.
Banks, Thomas R.
Barber, Clifford F.
Benedum, Darwin
Bevier, George M.
Boehms, Eugene F.
Bonar, R. E.
Boyer, Will W.
Boyle, Walter J.
Brown, Ira Otho
Chapell, D. O.
Closuit, E. M.
Coates, George H.
Coldwell, Charles H.
Colton, Earl G.
Colton, Howard F.
Cooper, Herschel H.
Corning, Leavitt, Jr.
Cotulla, R. E.
Curry, William H.
Daubert, Charles A.
Daugherty, C. G., Jr.
Davis, Thornton
Derden, J. H.
Dinsmoor, Carlton G.
Douglas, L. A.
Dovre, Adolph
Durward, Robert H.
Elms, Morris A.
Eyssell, Alfred R.
Finch, Elmer H.
Gilbert, A. C.
Gish, Wesley G.
Green, Guy E.
Grigsby, Garlnad O.
Gross, A. B.
Gully, Philip D.
Hammond, Weldon W.
Haring, Louis H., Jr.
Harrell, Marshall A.
Harvey, William W.
Henderson, H. H.
Herndon, Harold D.
Howeth, Irving K.
Hruby, Milton
Johnson, E. L.
Kearny, Clinton C.
Kelley, Ward W.
Keppler, Leo G.
Kidd, Gentry
Kirby, Grady
Kniker, Hedwig T.
Kolm, Robert N.
Krum, William M.
Lawton, Joe
Ley, Henry A.
Manthos, Atlee G.
Masterson, Reba B.
Matson, Martin
McDonald, Worth W.
Menger, Hubert Emil
Moore, Marion J.
Mossom, Stuart
Nelson, James C.
Nelson, Jean O.
Nessly, Howard E.
Newfarmer, Leo R.
Nicholls, William M.
Osborne, Robert R.
Owen, Edgar W.
Palmer, Leland L.
Patterson, Joseph M.
Petrick, Glen
Petsch, Arthur H.
Petty, Dabney E.
Petty, O. S.
Petty, Van A., Jr.
Pinkley, George R.
Porch, Edwin L., Jr.
Potter, Grover C.
Preece, Rae
Ratliff, Guy Marvin
Renick, B. Coleman
Richards, George L., Jr.
Rife, Byron
Robie, Robert Hodges
Ross, John C.
Row, Charles H.
Sandidge, John R.
Schmotzer, J. W.
Schoeneck, Philip S.
Schoolfield, R. F.
Semmes, Douglas R.
Shaw, Silas Frederick
Sheldon, Israel R.
Shelton, George H.
Sloss, James P.
Snider, L. B.
Snow, Arthur Leland
Souther, John B.
Spice, William H., Jr.
Sprague, William B.
Storm, Willis
Teel, Dick
Tobin, Don Freeman
Trenchard, John
Turner, Joseph H.
Wagener, Charles H.
Ward, Harold E.
Warner, Ralph E.
Whetsel, R. V.
Whitaker, Harvey
Wiegand, F. W.
Wilson, James, Jr.
Winfrey, Donald B.

SANATORIUM—Hakes, Willard R.
SEAGRAVES—Harrison, John W.
SEMINOLE—Barnhart, Carl F.
Woodward, T. P.
SEMYOUR
Kemp, Augusta Hasslock
St. Clair, Donald W.
SINTON—Dake, Helen Elizabeth
Garst, Jarvis
Tatum, James L.
TAYLOR—Grimes, Russell W.
TYLER—Alexander, C. I.
Bierman, Alfred C.
Briscoe, Glenn O.
Brundall, Laurence
Bunn, John R.
Burnett, T. J.
Burton, George E.
Cardwell, D. Harold
Cash, Thornton C.
Denton, Frank R.
Howard, Edward L.
Hudnall, James S.
Loetterle, Gerald John
Murphy, Boyd F.
Orr, Mark L.
Pirtle, George W.
Rice, Elmer M.
Robertson, Parker A.
Self, Selden R.
Shelby, Thomas H., Jr.
Trowbridge, Raymond M.
Wendlandt, E. A.
Wilson, Edward B.
Wright, Andrew C.
Youngmeyer, Ray
UVALDE—Getzendaner, Frank M.
VANDERBILT—Morrow, A. L.
VERNON—Smith, Edwin S., Jr.
VICTORIA—Johnston, Leslie A.
Travis, J. J.
WACO—Blank, Horace R.
Lane, Robert Cecil
Straley, H. W., III
WEATHERFORD—Smith, J. P.
WESLACO—Christner, J. B.
WICHITA FALLS
Autry, Vernon E.
Bean, Ward C.
Birk, Ralph A.
Bitgood, Ellen Posey
Bowen, James P.
Clark, Clifton W.
Clark, Joseph Marsh
Daniel, Orion A.
Davies, James Dudley
Davis, John R.
Drake, Robert T.
Emmerich, Harry H.
Engstrand, Clinton
Fonville, Herman A.
Fountain, H. C.
Gibbs, James F.
Harden, Lynn L.
Heninger, Dan D.
Hiller, C. F.
Kay, John A.
Kelly, Donald
Kimball, Edgar W.
Lindeblad, E. E.
Martin, P. M.
Maucini, Joseph J.
McCabe, William S.
McGaha, Charles P.
Patterson, Luter Edwin
Pettigrew, Virgil
Petty, T. F.
Punches, R. K.
Purcell, Paul E. M.
Rauch, Wayne C.
Roth, Robert
Russell, J. J., Jr.
Sanford, Wendell Glenn
Scholl, Guy J.
Seitz, J. R.
Smiley, H. F.
Stilley, Earl M.
Valerius, Claude N.
Wadsack, George E.
Waggoner, Stephen Gose
Wanenmacher, Joseph M.
Wing, Robert B.

UTAH

LOGAN—Williams, J. Stewart
SALT LAKE CITY
Bowen, Charles F.
Whittier, William H.

VERMONT

POULTNEY—Larrabee, David M.

VIRGINIA

BLACKSBURG—Holden, Roy J.
CHARLOTTESVILLE
McGill, William M.

WASHINGTON

FORT LEWIS—Kotick, O. F.
PULLMAN—Culver, Harold E.
Glover, Sheldon L.
SEATTLE—Umpleby, Joseph B.
Weaver, Charles E.

WEST VIRGINIA

CHARLESTON
Anderson, Ray Ball
Billingsley, J. E.
Brewer, Charles, Jr.
Fischer, O.
Lafferty, Robert C., Jr.
McClain, Alan H.
Simmons, Harvey J., Jr.
Stanton, Edward Cramon, Jr.
Ziebold, William O.
CLARKSBURG
Mayfield, William W.
Tollefson, E. H.
LEWISBURG
Argabrite, William Graeme
MORGANTOWN—Galpin, Sidney L.
Heck, Edward T.
Hennen, Ray V.
Price, Paul H.
Reger, David B.
Tucker, Rietz C.
WHEELING—Hubman, Ralph C

WISCONSIN

MADISON—Newell, Norman D.
Twenhofel, W. H.
MILWAUKEE—Raasch, Gilbert O.

WYOMING

CASPER—Barrett, Albert F.
Crawford, James Gilmore
Hares, C. J.
Krampert, E. W.
Larsen, Raymond M.
Mallory, R. W.
McCanne, Rolland W.
Nelson, Walter S.
Sielaff, Robert L.
LA BARGE—Minton, Robert J.
LARAMIE—Beckwith, R. H.
Espach, Ralph H.
Kivi, Wilho J.
Sansone, John B.
Snively, H. Norman
Thomas, Horace D.
ROCK SPRINGS
Nightingale, W. T.
THERMOPOLIS
Schwabrow, John T.

OUTSIDE UNITED STATES

ALBERTA

BLACK DIAMOND
Gleddie, Joseph
CALGARY—Bradford, Charles E.
Davies, Stanley J.
Galloway, John O.
Gray, John Gardiner
Howells, William Crompton
Hunt, Edwin H.
Hunter, Harry M.
Irwin, J. S.
Johnson, Russell V.
Link, Theodore A.
MacNeil, Donald J.
Sanderson, J. O. G.
Slipper, S. E.
Spratt, J. G.
Sproule, John Campbell
Thorne, B. L.
Williams, Thomas B.
EDMONTON—Allan, John Andrew
Ball, Max W.
TURNER VALLEY
Mackenzie, W. D. C.

ANGOLA

LUANDA—Roschen, Ernest C. H.

ARABIA

JEDDAH—Rigg, Robert M.

ARGENTINA

BUENOS AIRES
Bracaccini, Osvaldo I.
Breitenstein, Robert S.
Dessanti, R. N.
Leidhold, Clemens
Loomis, Harve
Rozlosnik, Andres
Severson, George A.
Stephenson, C. D.
Tarragona, Jose
CHUBUT—Catinari, Altavino E.
Fowler, Charles W., Jr.
LA PLATA
Fossa-Mancini, Enrico
Suero, Tomas
MENDOZA—Feruglio, Egidio
SAN PEDRO DE JUJUY
Fields, Harry B.
TARTAGAL
Harrington, George L.

AUSTRALIA

CANBERRA—Raggatt, Harold G.
BRISBANE—Wade, Arthur
MELBOURNE—Burnett, Jerome B.
Milstein, M.
Rudd, Eric A.
SOUTH PERTH—Moss, Frank
SYDNEY—Bremner, Carl St. J.
Maddox, Walter H.
Stanley, G. A. V.

AUSTRIA

LEOBEN—Petrascheck, Wilhelm

BARBADOS

BARBADOS—Senn, Alfred

BELGIAN CONGO

BOMA—Hoffmann, Charles R.
COSTERMANSVILLE
Touwaide, Marcel E.

BORNEO

BALIKPAPAN—Schlaich, E. P.

BRAZIL

BAIA—Clayton, Edgar H.

BRITISH COLUMBIA

KAMLOOPS—Sterrett, Douglas B.

BURMA

KHODAUNG—Lehner, Ernest J.
RANGOON—Gevaerts, E. A. L.

CANAL ZONE

ANCON—Link, Walter K.
BALBOA—Arnold, Emmett L.
PANAMA—Hilton, Willard O.

COLOMBIA

BARRANCA-BERMEJA
Hughes, Richard V.
Mulholland, Malcom M.
Sheldon, Robert A.
BARRANQUILLA
Graves, Allan Dexter
McCullough, E. A.
McNaughton, D. A.
von Estorff, F.
BOGOTA—Alvarado, Benjamin
Butler, John W., Jr.
Chappell, Walter M.
Christler, Harold E.
Dykstra, Bouwe
Etherington, Thomas J.
Garwood, Roland
Guerrero, Alberto Lobo-
Hatfield, Willis Charles
Hudson, W. T.
Lamon, Robert S.
McArthur, Donald
Notestein, Frank B.
Oppenheim, Victor E.
Saville, C. William
Sumner, Walton
Tabor, Lawrence L.
Trumpy, D.
Wheeler, Russell B.
Wilson, Joe G.
Wood, George R.
CUCUTA—Bowler, James W.
Bray, Vinton A.
DeBlieux, Charles
Hubman, Carl W.
Lee, Herbert V.
Vandenberg, Frederick E.
EL CENTRO
Acheson, Cyrus Harold
Colley, Bernard B.
HONDA—Aitken, W. Ernest

CUBA

CRISTO—Taylor, Ralph E.
HAVANA—Gravell, Donald W.
Harris, Richard C.
Klecker, John B.
Palmer, Robert H.
Walter, Karl L.

DOMINICAN REPUBLIC

AZUA—Barnett, John F.
TRUJILLO CITY—Arick, M. B.
Dohm, C. F.
Hunter, James W.
Lewis, J. Whitney

ECUADOR

GUAYAQUIL—Barrett, John F.
Bell, A. Lyndon
Loring, Ralph C.
Waring, W. W.
Wofford, H. R., Jr.
QUITO—Kehrer, L.
Tschopp, H. I.

EGYPT

CAIRO—Bailey, James P.
Brouwer, L. E. J.
Foley, Edward J.
Fournier, F. L.
Haight, Harold W.
Henry, Schuyler B.
Wallis, William E.
White, Kessack D.

ENGLAND

BERKSHIRE
Scott, Edwin Cooper
LONDON—Greig, Douglas A.
Howard, Arthur Henry
Illing, Vincent C.
Lees, George M.
Lepper, G. W.
Milner, Henry Brewer
Noble, Arthur H.
Templeton, James Clark
Thompson, A. Beeby
MIDDLESEX
Lovely, Herbert Richard
Taverne, N. J. M.
NOTTINGHAM—Vernon, Robert
SURREY—Hunter, Campbell M.

FRANCE

PARIS—DeCeccatty, Pavans
Schlumberger, Marcel
ST. RAPHAEL—Haas, Jean Otto
STRASBOURG—Pellissier, Andre

GERMANY

BERLIN—Bentz, A.
Stille, Hans
ESSEN-WERDEN—Mintrop, L.
GREIBERG—Krejci, Karl
HAMBURG
Behrmann, Rolf Bernhard
Kauenhowen, Walter
HANNOVER-KIRCHRODE
Tuchel, Georg
MAGDEBURG
Albrecht, Helmuth
WIEN—Bürgl, Hans

GUATEMALA

GUATEMALA CITY
Merritt, Roy W.

HAITI

PORT-AU-PRINCE
Kirk, Howard M.
Weidmann, Carl

HUNGARY

BUDAPEST—Walton, George C.

INDIA

KARACHI—Fullerton, Donald A.
Hoover, Malvern E.
Rose, Stanford L.
Whipple, G. Leslie

IRAN

TEHERAN—Afshar, Hadji Azadi
Karubian, R. Y.

IRAQ

BASRAH—Foran, William T.
Hotchkiss, Henry
KIRKUK—Henson, F. R. S.
QAIYARAH—Bennett, Johnson
RAMADI—Holmes, Ralph C.

ITALY

PALERMO—Fabiani, Ramiro
PARMA—Wiedenmayer, Carl
ROME—Zuber, Stanislav

JAPAN

TOKYO—Iki, Tsunenaka
Uwatoko, Kunio

JAVA

BATAVIA—Baak, Jan A.
Effinger, William L.
Hopper, Richard H.
Koch, Richard E.

MADAGASCAR

TANANARIVE—Marie, Marcel

MEXICO

MEXICO CITY
Alvarez, Manuel, Jr.
Ordoñez, Ezequiel
MONTERREY—Burbridge, C. E.
SALTILLO—Kane, William G.
TACUBAYA—Arellano, A. R. V.
Mullerried, F. K. G.
Salas, G. P.
TAMPICO—Grogan, Samuel A.

NETHERLANDS

AMSTERDAM—Doeglas, Dirk J.
BERGEN
van der Gracht, W. A. J. M.
THE HAGUE
Bauermann, Max K. H.
Cook, Carroll E.
Dreher, Otto
Frey, Alfred P.
Leyds, Louis W.
Schürmann, H. M. E.
van Gogh, F. A. A.

NEW ZEALAND

CHRISTCHURCH—Stinear, B. H.
GISBORNE—Barnwell, George F.
Bossard, Leon
Collins, Burton Wallace
Weymouth, A. Allen
GREYMOUTH—Pratt, Norman
PALMERSTON
Feldmeyer, Arthur E.
Nichols, Norval W.
STRATFORD
Thoms, Harold Wayne
TAIHAPE—Knight, Kack W.
WELLINGTON—Morgan, D. E.
Ongley, Montague

NICARAGUA

MANAGUA—Wilson, Thomas C.

ONTARIO

OTTAWA—Hume, George S.
TORONTO—Berwick, James D.
Hopkins, Oliver B.
Wheeler, Orby Clinton

PALESTINE

HAIFA—Browne, Richard Vernon
Daniel, E. J.
Gwinn, J. William
JERUSALEM—Wellings, F. E.

PAPUA

DARU—Barrow, Geoffrey
PORT MORESBY
Carey, S. Warren
Edward, Allan, K. M.
Gray, K. Washington
Mott, William Dick
O'Driscoll, Eugene Patrick

PERSIAN GULF

BAHREIN ISLAND
Barger, Thomas C.
Bramkamp, R. A.
Harriss, Trewhitt F.
Langham, N. T.
Parsons, Kenneth R.
Steineke, Max
Thomas, John William
KUWAIT—Sass, Louis Carl

PERU

CERRO DE PASCO
Jenks, William F.
LIMA—Iddings, Arthur
Mackenzie, Andrew N.
NEGRITOS—Frizzell, Don L.

PHILIPPINE ISLANDS

MANILA—Bain, H. Foster
Billings, M. H.
Corby, Grant W.
Kleinpell, Robert M.
Ross, J. D.

POLAND

BORYSLAW—Tolwinski, K.
WARSAW—Bohdanowicz, Charles

PORTUGAL

LISBON—Mendelsohn, Clive A.

ROUMANIA

BUCHAREST—Reed, Lyman C.
Voitesti, Ion Popescu
CAMPINA—Hegwein, Walter H.
PLOESTI—Hlauschek, H.
Small, Walt M.

SCOTLAND

EDINBURGH
Brown, James Chapman
PITTENWEEM FIFE
Williamson, Thomas F.

SPAIN

MADRID—Grove, B. H.

SUMATRA

MEDAN—Agnich, Fred J.
Dorn, Conrad L.
Fox, James P.
Hulsewe, Gerard Jan
Paap, Antonie
Storm, Alfred E.
PALEMBANG
Bard, Richards J.
McCobb, Harry W
Surber, N. Courtney
Weisbord, Norman E.
Winkler, B. O.
PANGKALAN BRANDAN
Koch, Thomas W.

SWITZERLAND

AARGAU—Gutzwiller, Otto
Muehlberg, Max
BASLE—Bernoulli, W.
Braendlin, E.
Erni, Arthur
Keller, Walter T.
Ritter, Ernest A.
Staehelin, Peter Karl
Vonderschmitt, Louis
LAUSANNE—Gagnebin, Elie A.
NEUCHATEL
Wasserfallen, Bernard
ZURICH—Frischknecht, Gustav
Kündig, Ernst

SYRIA

DEIR-EZ-ZOR—Badoux, Heli
Damesin, Leopold Constant F.
Pomeyrol, Rene

THAILAND

DHONBURI—Sreshthaputra, Vija

TRINIDAD

FOREST RESERVE—Payne, A. L.
PALO SECO
Wilson, Cedric Clarke
POINTE-A-PIERRE
Barr, Kenneth W.
Higgins, George Esmond
Kugler, Hans G.
Rogers, Harry Samuel
Suter, Hans H.
POINT FORTIN
Hutchison, Arthur G.
Savage, John D.
SAN FERNANDO
Penny, Frederick W.
SIPARIA—Scott, Gerald H.

TURKEY

ANKARA—Lokman, Kemal
Tasman, Cevat E.

URUGUAY

MONTEVIDEO
Vercesi, Daniel Rey

VENEZUELA

BARCELONA—Guntz, Henry A.
Hamilton, James R.
Hardin, Clifford G.
Hedberg, Hollis D.
Johnson, Frank Walker
Lockett, George L.
Mahoney, Roger S.
Pyre, Augustin
Riggins, Leslie B., Jr.
CARACAS—Aguerrevere, Pedro I.
Aguerrevere, Santiago E.
Andrews, Philip
Baird, C. A.
Boylan, Ebert E.
Brice, John W.
Brossard, Eugene E.
Champion, Joe A.
Cram, Edward C.
Crebbs, Chester M.
Dallmus, Karl F.
Davis, Irion G.
de Juana, Clemente Gonzalez
Evanoff, John
Floyd, Florin W.
Gerdes, C. H.
Giffin, Wilson C.
Grubbs, David M.
Huntley, Louis Guy
Jones, J. Byron
Kalb, J. L.
Kaufman, Godfrey F.
Kay, M. Kamen
Kerstetter, Dale D.
Martin, Francis I.
Nance, James W.
Nolan, Philip Edward
Perkinson, Floyd
Poulin, John A.
Rivero, Manuel
Sherman, Roger H.
Siegfus, Stanley S.
Stiles, Aden E.
Tipsword, Howard L.
Zuloaga, Guillermo
CARIPITO—Ackerman, E. Dumont
Borger, Harvey D.
Loeffler, Richard J.
Regan, John H.
Tuohy, John D.
CIUDAD BOLIVAR
Lee, Clarence L.
MARACAIBO
Beckman, Lawrence J.
Buddenhagen, H. J.
Dickinson, George
Douglas, John G.
Freie, A. J.
Grimsdale, Thomas F.
Hoffmeister, William S.
Jopling, Don Winter
Manger, G. Edward
Nash, Howard F.
Netick, Joe
Pintea, Michael, Jr.
Pospisil, Frank J.
Ratway, Joseph
Refshauge, B. C.
Sawyer, Joseph Herbert
Schaub, Hans Peter
Sorrells, Warren D.
Stauffer, H.
Sutton, Frederick A.
Tapp, Theodore L.
Tappolet, Werner
PUERTA LA CRUZ
Funkhouser, H. J.

TWENTY-SIXTH ANNUAL MEETING, HOUSTON, APRIL 2–4, 1941

ALEXANDER DEUSSEN
Houston, Texas

PERSONNEL

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

President, Luther C. Snider, Austin, Texas
Past-president, Henry A. Ley, San Antonio, Texas
Vice-president, John M. Vetter, Houston, Texas
Secretary-treasurer, Ed. W. Owen, San Antonio, Texas
Editor, W. A. Ver Wiebe, Wichita, Kansas

HOUSTON GEOLOGICAL SOCIETY

President, George S. Buchanan
Vice-president, A. P. Allison
Secretary, Leslie Bowling
Treasurer, Dugald Gordon

HOUSTON CONVENTION COMMITTEE CHAIRMEN

General, Alexander Deussen, 1006 Shell Building
Hotel and registration, Olin G. Bell, Humble Oil and Refining Company
Scientific exhibits, Paul Weaver, Gulf Oil Corporation
Program, Perry Olcott, Humble Oil and Refining Company
S.E.P.M., Marcus A. Hanna, Gulf Oil Corporation
S.E.G., H. B. Peacock, Geophysical Service Corporation
Research laboratory tours, W. A. Clark, Jr., Schlumberger Well Surveying Corp.
Technical equipment, Paul B. Leavenworth, Gulf Oil Corporation
Invitations, Wayne F. Bowman, 2342 Rice Boulevard
Field trips, J. A. Culbertson, Continental Oil Company
Finance, Ben C. Belt, Gulf Oil Corporation
Entertainment, George Sawtelle, Kirby Petroleum Company
Publicity and pamphlet, C. D. Lockwood, 314 Second National Building
Reception, Carleton D. Speed, Jr., Speed Oil Company
Transportation, K. H. Crandall, Standard Oil Company of Texas
Golf, Al Ferrando, Standard Oil Company of Texas

ANNOUNCEMENT—INVITATION

The twenty-sixth annual meeting of the Association will be held at the Rice Hotel in Houston, Texas, April 2, 3, and 4, 1941. The Houston Geological Society cordially invites the members of the Association, their wives and friends.

The fifteenth annual meeting of the Society of Economic Paleontologists and Mineralogists will be held on April 2, 3, and 4. The Society of Exploration Geophysicists will hold its eleventh annual meeting on April 1, 2, and 3. Both meetings will be at the Rice Hotel. Both societies are invited to attend the Association meetings, as well as the dance and other features.

PRE-CONVENTION SESSIONS

The S.E.G. will begin holding regular technical sessions on Tuesday, April 1, while the A.A.P.G. committees on Business, Applications of Geology, Research Groups and Publications will meet the same day.

Of special interest to members attending the pre-convention sessions will be the Research Dinner and Round-Table Discussion to be held Tuesday evening. The subject of the Round-Table discussion will be "Possible Future Oil Provinces in the United States and Canada." This discussion will be held under the chairmanship of A. I. Levorsen, who promises a very profitable evening with short résumés on these provinces by authorities.

REGISTRATION

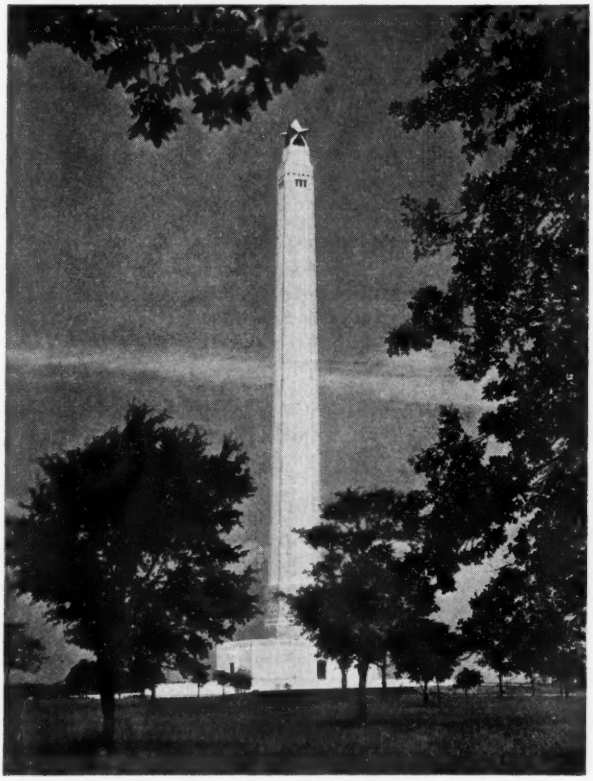
Members and guests are urged to register as soon as possible after securing hotel accommodations. The registration counter will be in the Lounge, Second Floor, Rice Hotel, and will be open from Monday noon until the conclusion of the meetings. There will be no registration fee.

SCIENTIFIC EXHIBITS

Paul Weaver, chairman of this committee, has spent considerable time, money, and effort in order to make these exhibits outstanding. His recent exhibit for the G.S.A. in Austin was very favorably commented upon by all who were fortunate enough to see it. In addition, several of the universities will have private exhibits, most of which have not heretofore been shown.

UNIVERSITY REUNIONS

Luncheons and dinners for university groups can be arranged upon request. Please contact the reception committee (Carleton D. Speed, chairman), as soon as possible so that space will be reserved. These arrangements should be made prior to arrival.



Courtesy, Houston Chamber of Commerce

San Jacinto memorial shaft at San Jacinto battleground, near Houston, marking spot where the Texas army under General Sam Houston defeated the Mexican army under Santa Ana, thus winning for Texas her independence. This structure is 567 feet high, 12 feet higher than the Washington Monument.

FIELD TRIPS

Houston is unique in the variety of field trips which can be offered from this city. There is the salt mine, where one can be lowered more than 1,500 feet down a shaft and see huge chambers flanked by walls of salt; there are the sulphur vats and tanks where liquid sulphur is cooled, solidified, and stored; there are the mounds one unexpectedly encounters in an otherwise

featureless plain which express topographically the intrusions of salt masses; there is the drilling in bays and the Gulf of Mexico where specially designed water equipment is used; there are the paraffine-dirt beds, the sour-water lakes, and the gas seepages which led the first geologists to vast reserves of oil; there is the subsidence in the earth surface due to withdrawals of oil, sulphur, and salt water which formed underground caverns in the salt and dome material.

In addition to the points of geologic interest, Houston has several points of historical interest to Texans and the Southwest. The San Jacinto Battlefield, where Texas won its independence from Mexico in 1836, is almost within the city limits. At this spot there has been erected a monument 570 feet in height with a museum of Texas history in its base. Likewise, Galveston bay and beach, both of which have played important roles in Texas history, are near by. The beach is one of the finest laboratories known for the study of beach deposits. This island was formerly used by Jean LaFitte as his center of operations during the days of piratical raids.

TECHNICAL PROGRAM

This year the regular order of the program will be slightly changed. Instead of having the joint sessions of the A.A.P.G., S.E.G., and S.E.P.M. with the presidential addresses on Wednesday, these will be held on Thursday and the regular technical sessions will be held Wednesday and Friday. For the joint meetings several prominent men in the industry have been asked to address the meeting after the presidential addresses. General papers on sedimentation, economic importance of various crude oils, and surface geology have been secured to be given by well known authorities in these fields of endeavor. Development papers will be read immediately preceding the technical papers on the district.

GOLF

The golf committee has arranged for luncheon and tournament at one of the country clubs on Friday, so bring your clubs with you. The Bostick Cup is at stake.

LADIES

And as for the ladies, we have just the thing: a style show. Don't you geologists keep your wives home on this account. Styles are better and cheaper in Houston than anywhere in the World. That is, the Texas World. And music for the style show and luncheon by George Olson!

We almost forgot to mention the garden tours and dance. The garden tour can't be surpassed in the United States. The Garden Club of America selected Houston two years in succession in which to hold its convention because of the beauty of the Houston gardens—azaleas and camellias will be in full bloom. Of course the dance is an occasion in itself. We need not mention that, but the same George Olson will play. For the music lovers, the St. Louis Symphony Orchestra under the direction of Vladimir Golschmann will play at the Music Hall on the night of April 1 (reservations should be made *immediately* with Mrs. Edna W. Saunders, c/o Levy Brothers, Houston, Texas).

HOTELS

The 26th annual meeting is attracting an exceptionally large number of members and friends. The several committees in charge of arrangements

request that you make your plans and reservations immediately. If you have not done so, the Hotel and Registration Committee advises you to wire your hotel immediately and request confirmation. The Rice, Lamar, Texas State, and Warwick are booked to capacity, and probably by the time this notice is published, very few rooms will be available in the other hotels.

It is urged that reservations be made as early as possible as the hotel managements will not agree to hold any of the 1,550 rooms allotted to this convention beyond March 20. Reservations requested after March 20 will have no priority over regular guests. The hotels are prepared to handle registrations promptly on arrival; but if pre-arrival hotel registration and room assignment are desired, a request for such registration should be sent to Olin G. Bell, chairman, Hotel Committee, P.O. Box 2180, Houston, Texas, together with your check of draft for deposit of $10.00. The hotel, type, and price of room desired, and the date and hour of arrival should be mentioned. In case such arrangements are made the guest should immediately upon arrival report to the A.A.P.G. registration booth, Lounge, Second Floor, Rice Hotel, and present his confirmation of registration, where room keys will be furnished direct by the committee in these pre-registration instances.

A special rate is available to *STUDENTS* only at the Rice Hotel. Groups of four to six students will be housed in large rooms equipped with individual beds and all modern conveniences at a cost of $1.25 per person provided that college department heads organizing these groups advise Olin G. Bell, P.O. Box 2180, Houston, Texas, before March 28, giving names and date of arrival of all students so that the proper number of rooms may be assigned.

HOTELS AND MINIMUM RATES

Hotel	*Rooms*	*Blocks from Rice*	*Without Bath*		*With Bath*	
			Single	*Double*	*Single*	*Double*
*Rice	1,000	—	—	—	$2.50	$4.00
Wm. Penn	175	5			2.50	4.00
*Warwick	153	51			2.50	4.00
Auditorium	175	2			2.50	4.00
*Lamar	500	5			2.50	4.00
*Texas State	400	3			2.50	4.00
San Jacinto	300	3	$1.50	$2.50	2.50	4.00
Ben Milam	250	6			2.50	4.00
Sam Houston	200	3			2.50	4.00
Cotton	175	3			2.50	4.00
Plaza	102	51			2.50	4.00
DeGeorge	150	6	2.00	3.00	2.50	4.00

* Booked to capacity.

TRANSPORTATION

There is no special convention rate in effect on the railroads. You should see your local ticket agent about any seasonal or regional round-trip excursion rates that may be available.

SCHEDULE OF EVENTS

Perry Olcott, chairman of the program committee, announces the following schedule of events and list of papers.

MONDAY, MARCH 31

MORNING

10:00 A.A.P.G. Executive Committee. President's Suite.

AFTERNOON

1:00 Registration: A.A.P.G., S.E.G., and S.E.P.M. Lounge, Second Floor.
3:00 S.E.G. Executive Committee. Room E, Second Floor. W. T. Born, chairman.

TUESDAY, APRIL 1

MORNING

GENERAL COMMITTEE MEETINGS

8:00 Registration. Lounge, Second Floor.
8:00 A.A.P.G. Scientific Exhibits. Paul Weaver, chairman. Between Ballrom and South American Room, Second Floor.
A.A.P.G. Permian Group. Ronald K. DeFord, chairman. Pine Room, Second Floor.
Technical Equipment Exhibits. Sam Houston Room and Foyers, Second Floor.
9:00 A.A.P.G. Committee to Recommend a New Method of Electing Officers. George S. Buchanan, chairman. Room B, Second Floor.
9:00 A.A.P.G. Committee on Application of Geology. C. E. Dobbin, chairman. Room E, Second Floor.
10:00 S.E.G. Technical Session. W. T. Born, chairman. H. B. Peacock, alternate. Ballroom, Second Floor.
10:00 A.A.P.G. Business Committee. W. B. Heroy, chairman. Albert Gregersen, vice-chairman. Ed. W. Owen, secretary. Lacquer Room, Second Floor.
10:00 A.A.P.G. Research Committee. A. I. Levorsen, chairman. French Room, Second Floor.
10:00 A.A.P.G. Committee for Publication. R. E. Rettger, chairman. Room B, Second Floor.

AFTERNOON

RESEARCH COMMITTEE MEETINGS

12:30 S.E.G. Luncheon. W. T. Born, chairman. South American Room, Room No. 1, Second Floor.
2:00 A.A.P.G. Business Committee—continued. Lacquer Room, Second Floor.
2:00 S.E.G. Technical Session. E. A. Eckhardt, chairman. Frank Goldstone, alternate. Ballroom, Second Floor.
2:00 A.A.P.G. Research Committee Conference Groups:
"Sedimentation and Reservoir Rock Conditions." Wayne Galliher, leader. F. W. Rolshausen and W. C. Krumbein, assistants. South American Room, Room A, Second Floor.
"Origin and Evolution of Oil." M. G. Cheney, leader. French Room, Second Floor.
"Migration and Accumulation of Oil." F. M. Van Tuyl, leader. Ben Parker, assistant. Pine Room, Second Floor.
"Relation of Oil Analyses to Stratigraphy." L. Murray Neumann, leader. Room B, Second Floor.
"Oil Field Waters." L. C. Case, leader. Room E, Second Floor.

EVENING

6:30 A.A.P.G. Research Committee Dinner. A. I. Levorsen, chairman. South American Room, Second Floor. Secure tickets at registration desk, Lounge, Second Floor.
8:00 A.A.P.G. Resarch Committee. Round-Table Discussion on subject: "Possible Future Oil Provinces in the United States and Canada." A. I. Levorsen, chairman. M. G. Cheney, co-chairman. Ballroom, Second Floor.
8:30 St. Louis Symphony Orchestra. Vladimir Golschmann, conducting. Music Hall, four blocks West. Reservations should be made with Edna Saunders, c/o Levy Bros., Houston.

WEDNESDAY, APRIL 2

MORNING

GULF COAST AREA

7:30 Registration. Lounge, Second Floor.
8:00 A.A.P.G. Scientific Exhibits. Between Ballroom and South American Room, Second Floor.

A.A.P.G. Permian Exhibits. Pine Room, Second Floor.
Technical Equipment Exhibits. Sam Houston Room and Foyers, Second Floor.

9:30 S.E.G. Technical Session. Andrew Gilmour, chairman. Henry C. Cortes, alternate. South American Room, Second Floor.

9:30 S.E.P.M. Technical Session. Carey Croneis, chairman. Lacquer Room, Second Floor.

9:30 A.A.P.G. Opening General Technical Session. (Presidential speeches *et cetera* to be heard at joint session with S.E.G. and S.E.P.M. on Thursday morning.) George S. Buchanan, chairman. Alexander Deussen, alternate. Ballroom, Second Floor.

Address of Welcome, Neal Pickett, Mayor of Houston (10 minutes).

9:40 Response, George S. Buchanan, president, Houston Geological Society.

9:50 Open Technical Session by L. C. Snider, president, A.A.P.G.

10:00 A.A.P.G. Technical Session, Gulf Coast District. George S. Buchanan, chairman. O. L. Brace, alternate. Ballroom, Second Floor.

12:00 Ladies Style Show and Luncheon. Rice Roof. Purchase tickets at registration desk, Lounge, Second Floor. Tickets, $1.00 each.
Music by George Olson; Styles by Sakowitz.

AFTERNOON

SOUTH TEXAS AND WEST TEXAS AREAS

1:30 A.A.P.G. Announcements, Nominations of Officers, Appointments of Committees. L. C. Snider, chairman. Ballroom, Second Floor.

1:30 S.E.G. Technical Session. R. D. Wyckoff, chairman, Herbert Hoover, Jr., alternate. South American Room, Second Floor.

1:30 S.E.P.M. Technical Session. John R. Sandidge, chairman. Lacquer Room, Second Floor.

2:00 A.A.P.G. Technical Session, South Texas Area. Fred P. Shayes, chairman, Gentry Kidd, alternate. Ballroom, Second Floor.

3:30 A.A.P.G. Technical Session, West Texas Permian Basin and Southeastern New Mexico. Robert E. King, chairman. Ronald K. DeFord, alternate. Ballroom, Second Floor.

THURSDAY, APRIL 3

MORNING

PRESIDENTIAL ADDRESSES AND SPEECHES

7:30 Registration. Lounge, Second Floor.

8:00 Ballot Boxes open until 5:00 P.M. Headquarters Booth, Second Floor.

8:00 A.A.P.G. Scientific Exhibits. Between Ballroom and South American Room, Second Floor.

8:00 A.A.P.G. Permian Exhibits. Pine Room, Second Floor.
Technical Equipment Exhibits. Sam Houston Room and Foyers, Second Floor.

8:00 A.A.P.G. Committee on Geologic Names and Correlations. John G. Bartram, chairman. Breakfast Meeting. Room E, Second Floor.

9:00 Joint Session, A.A.P.G., S.E.G., and S.E.P.M. L. C. Snider, chairman. Alexander Deussen, alternate. Ballroom, Second Floor.
Introduction and Thanks by Alexander Deussen (10 minutes).
Presidential Addresses (20 minutes each):
A.A.P.G., L. C. Snider, Department of Geology, University of Texas, "Petroleum Geologists in the National Defense Program."
S.E.G., W. T. Born, Geophysical Research Corporation, Tulsa, Oklahoma, "The Future of Geophysics."
S.E.P.M., Carey Croneis, Walker Museum of Paleontology, University of Chicago, "Micropaleontology Past and Future."
Special Addresses (30 minutes each):
Robert E. Wilson, president, Pan-American Petroleum and Transport Company and in charge of Petroleum Section, Raw Materials Division, Advisory Commission to the Council of National Defense, "Petroleum and the War."

INTERMISSION, 10 MINUTES

J. Edgar Pew, vice-president, Sun Oil Company, Philadelphia, Pennsylvania. "The Fifth Dimension in the Oil Industry."

N. C. McGowen, president, United Gas Pipe Line Company and Union Producing Company, Shreveport, Louisiana.

12:00 T.C.U. Luncheon, Gayle Scott, chairman. Room E, Second Floor.

12:00 University of Chicago Luncheon, informal. Pine Room, Second Floor.

12:00 Final registration period for all field trips, tours, and golf tournament. Lounge, Second Floor.

AFTERNOON

GENERAL PAPERS AND ROCKY MOUNTAIN AREA

1:30 Ladies Garden Tour. Register and secure tickets at desk in Lounge, Second Floor. No charge. Transportation will be at Texas Street entrance of the Rice Hotel.

1:30 Joint Session, A.A.P.G., S.E.G., and S.E.P.M. J. M. Vetter, chairman. Edgar W. Owen, alternate. Ballroom, Second Floor.

General Papers:

Edgar W. Owen, secretary-treasurer, A.A.P.G., with L. W. Wentz, San Antonio, Texas (25 minutes).

L. W. Storm, Schlumberger Well Surveying Corporation, Corpus Christi, Texas, "Resume of Current Opinion on Larger Features of Sedimentation in the Gulf Coast Region of Texas and Louisiana" (30 minutes).

H. D. Wilde, Humble Oil and Refining Company, Houston, Texas, "Why Crudes Differ in Value" (25 minutes).

Basil B. Zavoico, Chase National Bank, New York City, "Foreign Developments during 1939 and 1940" (20 minutes).

P. E. Fitzgerald, J. R. James, Ray Austin, Dowell, Inc., Tulsa, Oklahoma, "Laboratory and Field Observations of the Effect of Acidizing Oil Reservoirs Composed of Sand" (15 minutes).

INTERMISSION, 10 MINUTES

3:35 A.A.P.G. Technical Session, Rocky Mountain Area. Harold N. Hickey, chairman. C. E. Dobbin, alternate. Ballroom, Second Floor.

3:30 S.E.P.M. Research Committee. W. H. Twenhofel, chairman. Lacquer Room, Second Floor.

5:00 S.E.P.M. Council Meeting. Carey Croneis, chairman. Room E, Second Floor.

EVENING

9:00 Joint A.A.P.G. S.E.G., and S.E.P.M. Dance and Breakfast. Buy Tickets in Lounge, Second Floor, before noon Thursday. Tickets, $3.00 each. Ballroom, Second Floor. Music by George Olson.

FRIDAY, APRIL 4

MORNING

SOUTH MID-CONTINENT AND CENTRAL AND EASTERN STATES

8:00 Registration. Lounge, Second Floor.

8:00 Scientific Exhibits. Between Ballroom and South American Room, Second Floor.
A.A.P.G. Permian Exhibits. Pine Room, Second Floor.
Technical Equipment Exhibits. Sam Houston Room and Foyers, Second Floor.

9:00 A.A.P.G. Tours through Houston Research Laboratories. Register at booth in Lounge, Second Floor, before noon Thursday. W. A. Clark, chairman. Transportation at Texas Street entrance of Rice Hotel. Transportation, $1.00.

9:00 A.A.P.G. Technical Session, South Mid-Continent Area. L. W. MacNaughton, chairman. J. R. Seitz, alternate. Ballroom, Second Floor.

9:30 S.E.P.M. Technical Session. Gayle Scott, chairman. Lacquer Room, Second Floor.

10:00 A.A.P.G. Field Trip to Hockley Salt Mine. Bus leaves Texas Street entrance of Rice Hotel, returning about 1:30 P.M. Trip is limited to 25 men, so register before noon Thursday in Lounge, Second Floor. A. G. Wolf, conducting. Transportation Fee, $1.50.

10:30 A.A.P.G. Technical Session, Central and Eastern States. L. M. Clark, chairman. A. H. Bell, alternate. Ballroom, Second Floor.

11:00 S.E.P.M. Annual Business Meeting. Carey Croneis, chairman. Lacquer Room, Second Floor.

12:00 Humble Oil and Refining Company Luncheon. South American Room, Room No. 1, Second Floor.

AFTERNOON

BUSINESS MEETING, NORTH MID-CONTINENT AND CALIFORNIA AREAS

1:00 Cars leave Main Street entrance of Rice Hotel for Brae Burn Country Club for Gulf Tournament which starts at 1:30. Players must register before noon Thursday in Lounge, Second Floor. Greens Fee and Transportation, $1.50 each. Bostick Cup and several other prizes to be awarded at Club immediately after the tournament. Al Ferrando, chairman.

1:00 Field Trip to Galveston Bay Water Drilling. Leave from Texas Street entrance of Rice Hotel by bus to Clifton-by-the-Sea; from there a 3-hour trip by water, returning to Houston about 6 P.M. Register before noon Thursday in Lounge, Second Floor. Transportation $1.50. J. A. Culbertson, chairman, E. J. Hamner, conducting. G. J. Smith, O. C. Clifford, assistants.

1:30 A.A.P.G. Twenty-Sixth Annual Business Meeting and Announcement of Election Results. L. C. Snider, chairman. Henry A. Ley, alternate. Ballroom, Second Floor.

2:00 A.A.P.G. Tours through Houston Research Laboratories. Start from Texas Street entrance of Rice Hotel. Register before noon Thursday in Lounge, Second Floor. W. A. Clark, chairman. Transportation, $1.00.

2:30 A.A.P.G. Technical Session, North Mid-Continent Area. Anthony Folger, chairman. Joseph L. Borden, alternate. Ballroom, Second Floor.

3:00 A.A.P.G. Field Trip to Hockley Salt Mine. Bus leaves Texas Street entrance of Rice Hotel, returning about 6:30 P.M. Register before noon Thursday in Lounge, Second Floor. Trip is limited to 25 men. Transportation $1.50. M. A. Hanna, conducting.

3:30 A.A.P.G. Technical Session, State of California. Frank Hudson, chairman. Earl B. Noble, alternate. Ballroom, Second Floor.

SATURDAY, APRIL 5

MORNING

9:00 Field Trip to Pierce Junction, Hastings, Galveston, Hoskins Mound, Sulphur Mine, West Columbia, Damon Mound, and return. Leave by bus from Texas Street entrance of Rice Hotel. Register before noon Friday in Lounge, Second Floor. Return about 6:30 P.M., Transportation $2.50. M. M. Sheets, James K. Rogers, Jerome S. Smiser, Wayne Bowman, John M. Brokaw, conducting.

10:00 A.A.P.G. Joint Meeting of Retiring and Incoming Executive Committees. Pine Room, Second Floor.

PAPERS TO BE PRESENTED

O. L. BRACE—Review of Developments in 1940, Gulf Coast and Upper Texas and Louisiana.

URBAN B. HUGHES—Developments in Mississippi in 1940.

TOM MCGLOTHLIN—Notes on the Geology of Mississippi.

CARL B. RICHARDSON—A Comparative Study of the Origin and Distribution of the Gulf Coast Tertiary Sediments.

C. B. ROACH—A Subsurface Study of the Jennings Dome, Acadia Parish, Louisiana.

A. N. WILSON—Basal Vicksburg Sand of the Texas Gulf Coast.

MICHEL T. HALBOUTY—Oil and Gas Stratigraphic Reservoirs in the University Oil Field, East Baton Rouge Parish, Louisiana.

DOROTHY A. JUNG and DORIS S. MALKIN—Marine Sedimentation and Oil Accumulation on the Gulf Coast.

CLARENCE E. BREHM—The Pickens Pool, Yazoo County, Mississippi.

S. RUSSELL CASEY and RALPH B. CANTRELL—The Davis Sand Lens, Hardin Field, Liberty County, Texas.

JOSEPH M. WILSON—The Geology of the South Cotton Lake Field, Liberty County, Texas.

PHIL F. MARTYN and CHARLES H. SAMPLE—Oligocene Stratigraphy of the East White Point Field, San Patricio County, Texas.

A. W. WEEKS—Late Cenozoic Deposits of Texas Coastal Plain between Brazos River and Rio Grande.
H. B. STENZEL—Sedimentary Cycles in the Eocene of the Texas Gulf Coastal Plain.
TAYLOR COLE, ROBERT I. DICKEY, and EDGAR KRAUS—Developments in West Texas and Southeastern New Mexico.
W. T. SCHNEIDER—Geology of the Wasson Field, Gaines and Yoakum Counties, Texas.
W. M. OSBORN—The Stratigraphic Trap of the Slaughter Field of West Texas.
W. A. WALDSCHMIDT—Progress Report on Microscopic Examination of Permian Crude.
TAYLOR COLE—Subsurface Study of the Ellenburger Formation in West Texas.
L. W. STORM—Résumé of Current Opinion on Larger Features of Sedimentation in the Gulf Coast Region of Texas and Louisiana.
H. D. WILDE—Why Crudes Differ in Value.
BASIL B. ZAVOICO—Foreign Developments During 1939 and 1940.
P. E. FITZGERALD, J. R. JAMES, RAY AUSTIN—Laboratory and Field Observations of the Effect of Acidizing Oil Reservoirs Composed of Sand.
C. E. DOBBIN—Developments in Rocky Mountain Region in 1940.
HARRY OBORNE—Paleozoic Correlation between the Rocky Mountain Front Range and the Texas-Oklahoma Panhandle.
W. A. WALDSCHMIDT—Results of Petrographic Studies of Sandstone Cores from Rocky Mountain Structures.
W. C. TOEPELMAN—Microfaunas of the Niobrara and Benton in the Foothills of Northern Colorado.
H. F. SMILEY—New Developments in North and West Central Texas, 1940.
W. J. HILSEWECK—The Walnut Bend Pool of Cooke County, Texas.
H. N. FISK—The Midway-Wilcox Deltaic Mass.
J. O. BARRY—Correlation of Wilcox Faunal Units of Louisiana.
R. J. LEBLANC—Correlation of the Upper Midway Fauna of Louisiana.
GROVER MURRAY, JR.—Midway Stratigraphy of the Sabine Uplift.
ALFRED H. BELL—Oil and Gas Development in the Eastern Interior Basin in 1940.
PAUL H. PRICE and A. J. W. HEADLEE—The Geochemistry of Natural Gas in the Appalachian Province.
E. T. HECK—Gay-Spencer-Richardson Oil and Gas Trend in West Virginia.
MAX W. BALL, T. J. WEAVER, and DOUGLAS S. BALL—Shoestring Sand Gas Fields of Michigan.
L. E. WORKMAN and I. T. SCHWADE—Subsurface Strata between the Base of the Osage Group and the Top of the Devonian Limestone in Illinois.
JOSEPH PURZER and WARREN B. WEEKS—Development in Southern Arkansas and Northern Louisiana during 1940.
LEO HENDRICKS—Correlation of Subsurface Sections with Outcrops of the Ellenburger Formation of Texas.
JAMES L. CARLTON—Geology of Bartelso Oil Field, Clinton County, Illinois.
PARK J. JONES—Introduction to a Technique for Estimating Oil Reserves.
R. P. GRANT—Oil and Gas Developments in Michigan in 1940.
EDWARD A. KOESTER—Developments in North Mid-Continent in 1940.
LUTHER KENNEDY *et al.*—Occurrence of Oil in Pennsylvanian Sand Stratigraphic Traps in Eastern Oklahoma and Southeastern Kansas.
EDWIN A. DAWSON—Eastern Oklahoma.
J. A. MULL—Stream Channels Applied to the Arbuckle of the Central Kansas Uplift.
EUGENE H. VALLAT—Brief Review of Exploration Work in California during 1940.
ROLLIN ECKIS—The Stevens Sand, Southern San Joaquin Valley, California.
E. W. GALLIHER and E. R. ATWILL—Methods of Stratigraphic Study Used in California.
R. W. SHERMAN—Del Valle Oil Field, Los Angeles County, California.
ALEX CLARK—Pre-Miocene Stratigraphy of Bakersfield Area, California.
A. F. WOODWARD—Recently Discovered Middle Miocene Production in the Inglewood Oil Field.
WILLIAM W. PORTER II and PAUL P. GOUDKOFF—Age of Shale in Amoura-Uscari Area, Costa Rica.

PAST AND PRESENT OFFICERS OF THE ASSOCIATION

Elected In	*At*	*President*	*Vice-President*[1]	*Secretary-Treasurer*[2]	*Editor*[3]
1917	Tulsa	J. Elmer Thomas	Alex. Deussen	M. G. Mehl	C. H. Taylor
1918	Oklahoma City	Alex. Deussen	I. C. White[4]	W. E. Wrather	C. H. Taylor
1919	Dallas	I. C. White[4]	Irving Perrine	C. E. Decker	C. H. Taylor
1920	Dallas	W. E. Pratt	Alex. W. McCoy	C. E. Decker	R. C. Moore
1921	Tulsa	G. C. Matson[5]	G. C. Gester	C. E. Decker	R. C. Moore
1922	Oklahoma City	W. E. Wrather	Max W. Ball	C. E. Decker	R. C. Moore
1923	Shreveport	Max W. Ball	F. W. DeWolf	C. E. Decker	R. C. Moore
1924	Houston	J. H. Gardner	E. G. Gaylord	C. E. Decker	R. C. Moore
1925	Wichita	E. L. DeGolyer	R. S. McFarland	C. E. Decker	R. C. Moore
1926	Dallas	Alex. W. McCoy	C. R. McCollom	Fritz L. Aurin	J. L. Rich
1927	Tulsa	G. C. Gester	Luther H. White	David Donoghue	J. L. Rich
1928	San Francisco	R. S. McFarland	J. E. Elliott	David Donoghue	J. L. Rich
1929	Fort Worth	J. Y. Snyder[6]	Fred H. Kay	A. R. Denison	F. H. Lahee
1930	New Orleans	Sidney Powers[7]	Ralph D. Reed[8]	Marvin Lee	F. H. Lahee
1931	San Antonio	L. P. Garrett	L. C. Decius	Frank R. Clark	F. H. Lahee
1932	Oklahoma City	F. H. Lahee	R. J. Riggs	W. B. Heroy	R. D. Reed[8]
1933	Houston	Frank R. Clark	George Sawtelle	W. B. Heroy	L. C. Snider
1934	Dallas	W. B. Heroy	E. B. Hopkins[10]	M. G. Cheney	L. C. Snider
1935	Wichita	A. I. Levorsen	F. A. Morgan	E. C. Moncrief	L. C. Snider
1936	Tulsa	Ralph D. Reed[8]	C. E. Dobbin	Chas. H. Row	L. C. Snider
1937	Los Angeles	H. B. Fuqua	C. L. Moody	Ira H. Cram	W. A. Ver Wiebe
1938	New Orleans	D. C. Barton[9]	H. W. Hoots	Ira H. Cram	W. A. Ver Wiebe
1939	Oklahoma City	Henry A. Ley	L. M. Neumann	Ed. W. Owen	W. A. Ver Wiebe
1940	Chicago	L. C. Snider	John M. Vetter	Ed. W. Owen	W. A. Ver Wiebe

[1] From March, 1929, to March, 1932, the corresponding office was *first vice-president.*
[2] From March, 1929, to March, 1932, the corresponding office was *second vice-president in charge of finances.*
[3] From March, 1929, to March, 1932, the corresponding office was *third vice-president in charge of editorial work.*
[4] Died, November 25, 1927.
[5] Died, January 3, 1940.
[6] Died, January 10, 1939.
[7] Died, November 5, 1932.
[8] Died, January 29, 1940.
[9] Died, July 8, 1939.
[10] Died, July 5, 1940.

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VOL. 25, NO. 3 (MARCH, 1941), PP. 546-550, 1 FIG.

Memorial

MARIUS ROBINSON CAMPBELL
(1858–1940)

Marius R. Campbell, principal geologist, United States Geological Survey (retired), died at Pinellas Park, Florida, December 7, 1940, in his eighty-second year, after a long illness.

Campbell's great grandfather, William Marshall, was a Quaker who came to America from England in the pre-Revolutionary war period and settled near Philadelphia. He was a conscientious objector to war and, refusing to take up arms against England when the colonies revolted, he was practically driven from Pennsylvania. Marshall went to South Carolina, where he was joined by Isaac Davis, a Welshman, and James Campbell, a Scotchman. Finding conditions in South Carolina little different from those in Pennsylvania, Campbell and Davis, who had married daughters of Marshall, moved to the Western Reserve and settled about 40 miles southeast of Cleveland, Ohio. There, in 1852, Campbell's son Alvah, who was a carpenter, married Davis' daughter Eliza. In 1854 Alvah and Eliza Campbell, deciding to try their fortune farther west, moved to Garden Grove, Iowa, where Marius R. Campbell was born, September 30, 1858.

The Campbells, after spending a few years in Iowa, returned to their former home in Ohio, where Marius grew up. His father purchased a small farm, but suffered so much from asthma that he could do only small jobs at carpentry, and Marius did most of the farm work. He went to school whenever there was a favorable opportunity and attended a business college in Cleveland. There he "worked so steadily that [he] was elevated to a professorship at a reasonable salary."[1]

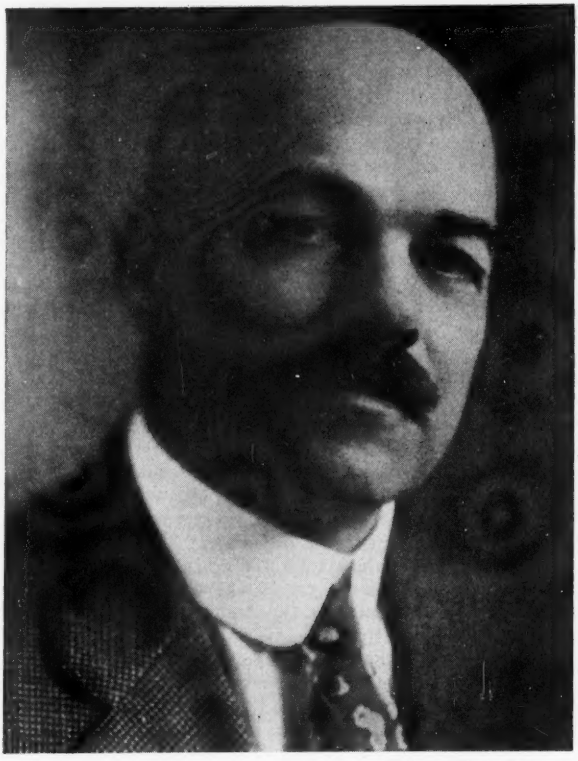
After he had spent about a year teaching in the business college a friend, who had recently graduated from Ohio State University, told him that he planned to become a railroad construction engineer. This fired Campbell's ambition and he decided to do likewise. He resigned his position at the business college and went to Columbus, where he presented his case to the faculty, stating that he could not take a complete course in engineering but that he wanted enough to take up the work of railroad construction. His request was granted with the proviso that he could not obtain a degree, and Campbell selected the following courses for the year 1885–86: railroad construction, geology under Professor Edward Orton, higher mathematics, astronomy, and chemistry. In all of these courses he "stood with the highest."

Campbell wrote concerning his work at the university:

> I was at once fascinated by the teaching of Professor Edward Orton, the State Geologist of Ohio, and I volunteered to assist him in preparing his manuscripts and illustrations. I was a fairly good draftsman and I assisted him in the preparation of much of his material. In return he frequently took me with his classes to study geology in the field, and we frequently went as far as Cincinnati. He also sent me on special trips to the various oil fields. I shall never forget his kindness and his earnest endeavor to acquaint me with the fascinating features of geology.

[1] In preparing this memorial the writer has used some biographical notes written by Mr. Campbell a short time before his death.

While working at the State University an offer of a job on railroad construction in Illinois was accepted by Campbell and carried through to completion. He then taught in a business college at Albany, New York. Before the end of the second year's work at Albany, Campbell received a letter from Orton asking why he had not tried for a position on the United States Geo-



Blakeslee Klintworth, Tampa

MARIUS R. CAMPBELL

logical Survey. Campbell answered that he did not know of such an organization and that he had some doubts about his ability to do geologic work. To this Orton replied that he had arranged for Campbell's appointment as assistant on one of the Survey's field parties. Reporting for duty at Washington, July 1, 1888, Campbell was assigned as assistant to C. W. Hayes, by Major Powell, director of the Survey.

This appointment proved to be the turning point in Campbell's career. Hayes, a highly trained and brilliant geologist, soon realized that his raw recruit had the "makings" of a geologist and Campbell recognized his good

fortune in being assigned to Hayes. They became devoted friends and as a result of the training he received, Campbell in 1890, after two seasons of work in the Appalachian region, was given charge of a party in the Tennessee coal field.

Thereafter Campbell's advancement was assured. He spent the succeeding 13 years in detailed stratigraphic, structural, and economic work in the coal fields of Tennessee, Kentucky, Virginia, West Virginia, and Pennsylvania.

One of the interesting events in Campbell's early work in the coal fields was the checking of correlation of the coal measure beds as determined by tracing in the field against paleobotanical work by David White. Up to the time of White's work in the eighteen nineties, paleobotany was not considered of much value in detailed correlation. David White had, however, through close study of a large collection of Carboniferous plants in the National Museum, concluded that they constituted a valuable guide to the age of the formation in which they occurred. White spent three field seasons with Campbell, with complete agreement between them, although at that time there were considerable differences of opinion among geologists concerning the correlations.

In 1900 Campbell was given supervision of the coöperative geologic work in Pennsylvania between the recently established Topographic and Geologic Survey Commission of Pennsylvania and the United States Geological Survey. This work resulted in the publication of folios and bulletins on numerous quadrangles in the coal, oil, and gas fields of western Pennsylvania, which were mapped in more detail than previously had been done, and the geologic structure was shown by structure contours which have proved so useful in depicting the structure of oil and gas fields. Campbell was among the first to use structure contours, in his map in the Pocahontas folio published in 1896. In recognition of this pioneer detailed stratigraphic and structural work in the eastern coal, oil, and gas fields, Campbell many years later was elected an honorary member of the American Association of Petroleum Geologists.

From these activities in the eastern coal fields, Campbell was assigned in 1904 to the western coal fields in connection with the Louisiana Purchase Exposition at St. Louis. Campbell was appointed one of a committee of three, the others being Joseph A. Holmes and Edward W. Parker, to have charge of the fuel-testing plant at St. Louis. The object of the plant was to test in various ways the great variety of coals west of the Mississippi River to determine their best use. Campbell's share of the work was to obtain carload lots of representative coal from the principal western fields.

An eventual outcome of the work of the coal-testing plant was the organization of the United States Bureau of Mines in 1910. This work also stimulated the systematic study of the coal fields in the western states by the United States Geological Survey. In 1906 a section of Economic Geology of Fuels was established in the Division of Geology and Campbell was designated geologist in charge, to have general supervision of investigations of coal, lignite, peat, oil, and gas by the Geological Survey.

Prior to 1905 the United States Geological Survey had made no effort to examine and map the coal fields of the western states in detail. There was little systematized knowledge about the quantity and quality of coal on the public lands, and the sale of coal lands had no scientific basis. In 1906, acting under instructions from President Theodore Roosevelt, the Secretary of the

Interior withdrew from entry 64 million acres of supposed coal lands and the Geological Survey was commissioned to classify this land and appraise its value. By 1908 the first reasonably accurate map of the coal fields of the country was prepared on which the coal fields were classified according to the rank of the coal. The map also showed an estimate of tonnage of coal in the ground. This was the first attempt to make a quantitative estimate of the coal reserves of the entire country.

The next attempt to improve this map and the estimates of tonnage was made by Campbell on the invitation of the executive committee of the 12th International Geological Congress held at Ottawa, Canada, in 1913. The results are incorporated in the report (Vol. 1) on the coal resources of the world.

In 1908 Campbell in a memorandum to the director of the Geological Survey suggested the desirability of the Survey's publishing a series of guidebooks, to be written in popular language, describing the geology along the routes of the principal transcontinental railroads, the object being to interest the traveler in what he sees from the car window. The suggestion was adopted and Campbell prepared the first and fifth of the guidebooks—on the Northern Pacific route (*Bulletin 611*) and the Denver and Rio Grande Western route (*Bulletin 707*). Parts of the field seasons 1910 to 1913 were spent by Campbell in a study of the physiography, stratigraphy, and structure of Glacier National Park.

Campbell was a life-long student of physiography and, as opportunity permitted, throughout his career he wrote papers on the development of the earth's surface. In 1893, five years after joining the Survey, he prepared, with C. W. Hayes, a paper on the geomorphology of the Southern Appalachians, which "placed the authors in the front rank of American physiographers."[2] Among his papers on physiography the following titles indicate the scope of his interests: "Erosion at Base Level," "Tertiary Changes in the Drainage of Southwest Virginia," "Hypothesis to Account for Extra-Glacial Abandoned Valleys of the Ohio Basin," "Geomorphic Development of Northern Pennsylvania and Southern New York," "Origin of Scenic Features of Glacier National Park." At the time of his death he had practically completed an elaborate catalogue of geomorphic terms.

Campbell was the author of many official reports of the Geological Survey, including 15 folios of the *Geologic Atlas of the United States* and numerous bulletins. Also, he wrote many papers that were published in scientific journals.

He served as a member of the Geological Survey's Land Classification Board, as chairman of the physiographic committee, and as chairman of the committee on formation names. He retired from the Survey in 1932 at the age of 74. The last years of his life were spent in Florida.

He was a member of many scientific societies, including the Geological Society of America, the American Institute of Mining and Metallurgical Engineers, Geological Society of Washington (president, 1908), Association of American Geographers (president, 1927), Society of Economic Geologists (president, 1930), American Association of Petroleum Geologists (elected honorary member in 1934). He was a member of the Cosmos Club, of Washington, D. C.

[2] Alfred H. Brooks, "Memorial of Charles Willard Hayes," *Bull. Geological Society of America*, No. 28 (1917).

Campbell had a charming personality and endeared himself to those who came in close contact with him. Especially is this true of the many young geologists who, as his assistants, knew him intimately and had the benefit of his personal training. Several score of men who became leading geologists of the country owe their success in no small degree to their association with Mr. Campbell.

Marius Campbell, on November 5, 1890, married Margaret Stevenson, of Middletown, New York, who survives him. Their marriage was ideally happy and they celebrated their 50th anniversary a month before Mr. Campbell's death.

G. B. RICHARDSON

WASHINGTON, D. C.
January, 1941

(*Continued from p. 445*)

Gid Calmese Mayfield, Dallas, Tex.
L. W. MacNaughton, Robert H. Cuyler, Albert E. Oldham
Joseph Bode Mountjoy, Atlanta, Ill.
Delmar R. Guinn, W. D. Anderson, Carl F. Barnhart
Thomas Jefferson Newbill, Jr., San Francisco, Calif.
H. F. Davies, W. O. Thompson, J. M. Kirby
Donald L. Norling, Wichita Falls, Tex.
L. R. Fortier, R. E. Shutt, W. C. Bean
Manley Osgood, Jr., Saginaw, Mich.
Kurt H. de Cousser, Raymond S. Hunt, Jed B. Maebius
Lowell Edwin Redwine, Shafter, Calif.
E. K. Soper, W. S. W. Kew, M. Van Couvering
Parry Reiche, Albuquerque, N. Mex.
C. E. Needham, Carlton D. Hulin, Georges Vorbe
William Thomas Rothwell, Jr., Long Beach, Calif.
H. W. Hoots, M. L. Natland, Frank A. Morgan
John William Ruth, Arcadia, Calif.
W. S. W. Kew, G. C. Gester, Herschel L. Driver
Melville William Sherwin, Dallas, Tex.
Stanley G. Elder, H. J. Weeks, H. L. Griley
Benjamin Titus Simmons, Houston, Tex.
Lon D. Cartwright, R. L. Beckelhymer, M. T. Halbouty
John Peter Smith, Wichita, Kan.
E. O. Markham, P. K. Cochran, M. W. Fuller
John A. Veeder, Shawnee, Okla.
J. Lawrence Muir, Robert L. Cassingham, William R. Gahring
Leon Robert Vesely, Houston, Tex.
James W. Kisling, Jr., Dale L. Benson, J. P. Thompson
Robert Thompson White, Bakersfield, Calif.
E. W. Galliher, Rollin Eckis, Drexler Dana
Charles Freeman Word, Midland, Tex.
K. B. Nowels, E. F. Boehms, Robert H. Cuyler
George Feick Yunck, Clay City, Ill.
Lynn K. Lee, Ira H. Cram, L. J. Fulton

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 25, NO. 3 (MARCH, 1941), PP. 551-560

AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

CHARLES M. CROSS, of the Tide Water Associated Oil Company, San Francisco, California, has resigned from the Association committee for publication, because he has entered the Army for active duty.

GEORGE A. MUSSELMAN, of the Carter Oil Company, has changed his address from Mattoon, Illinois, to Seminole, Oklahoma.

PAUL WEAVER, chief geophysicist of the Gulf Oil Corporation at Houston, Texas, delivered a paper on "The Present Evidence on the Source of Salt in the Gulf Coast Plains," before the South Texas Geological Society at San Antonio, Texas, January 17. Among those present were A.A.P.G. president L. C. SNIDER, H. P. BYBEE, F. L. WHITNEY, and R. H. CUYLER, all from the department of geology at the University of Texas, Austin.

CHARLES J. HARES, of the Ohio Oil Company, is returning to Casper, Wyoming, from Marshall, Illinois. FRED FUNK has moved from Casper to Findlay, Ohio.

E. BRAENDLIN, formerly with the Astra Romana, Campina, Rumania, has moved to Speiserstrasse 89, Basel, Switzerland.

W. D. CHAWNER, for the past 4 years engaged in geological work in Papua, may now be addressed at the School of Geology, Louisiana State University, Baton Rouge, Louisiana.

GEORGE E. BURTON, of the Sun Oil Company, has moved from Midland to Tyler, Texas.

CLIFFORD L. WILLIS, of the Carter Oil Company, has been transferred from Aberdeen, Mississippi, to Ardmore, Oklahoma.

D. H. CARDWELL, of the Sun Oil Company, has been transferred from Wichita Falls to Tyler, Texas.

GEORGE M. CLEMENT, of The Texas Company, has been transferred from Shreveport to New Orleans, Louisiana.

GAYLORD O. MICKELSON, graduate of the University of Wisconsin, completed a year of graduate work at Michigan State College, and during the past 6 months has been gaining Mid-Continent experience in the field and office with the General Geophysical Company. Mail will reach him if addressed to 1211 North Cheyenne Avenue, Tulsa, Oklahoma.

BEVERLY B. BRADISH, geologist with the Carter Oil Company, has moved from Bismarck, North Dakota, to McCook, Nebraska.

MARION H. FUNK, geologist with the Sun Oil Company, has changed his mailing address from Lubbock to Box 424, Midland, Texas.

W. G. WOOLNOUGH, first incumbent of the position of geological adviser, Commonwealth of Australia, retired on January 15. He is succeeded by H. G. RAGGATT.

STEVE C. MAPLES, JR., of Tulsa, Oklahoma, is employed as assistant engineering draftsman in the United States Coast and Geodetic Survey at Washington, D. C.

SAM W. WELLS has moved from Ada to Apartment 402, 12 E. 12th Street, Tulsa, Oklahoma.

REGINALD G. RYAN has moved from Baton Rouge, Louisiana, to 417 West Clay, Houston, Texas.

WILLIAM G. GREEN, president of Engineering Laboratories, Inc., Tulsa, Oklahoma, is the new president, and GERALD H. WESTBY, president of Seismograph Service Corporation, Tulsa, is the new vice-president, of the Tulsa chapter of Nomads.

HUBERT E. BALE, consulting geologist of Oklahoma City, talked before the Ardmore Geological Society at Ardmore, Oklahoma, recently, on "Evaluation of Oil and Gas Properties."

FRANK A. OYSTER has closed his office in Evansville, Indiana. He is maintaining an office at 924 North Broadway, Wichita, Kansas, for consulting work and operating in the Kansas and Texas fields.

ROBERT F. IMBT, consulting geologist of Fort Worth, Texas, spoke before the Fort Worth Geological Society, January 13. His subject, "Experiments with Light, Shadows, and Contours," dealt with the application of shading to the finished contoured map to facilitate interpretation of the map by persons other than geologists.

Copies of the cross section extending from Callahan County to Grayson County, Texas, prepared by the Fort Worth Geological Society and exhibited at the Austin meeting of the Geological Society of America, are available at $2.50 per copy. Address requests to W. J. HILSEWECK, Box 1290, Fort Worth, Texas.

JAMES I. DANIELS maintains his office as a consulting petroleum geologist at 814 Union National Bank Building, in the offices of the Southland Royalty Company, Wichita, Kansas.

The officers of the Fort Worth Geological Society, Fort Worth, Texas, are: president, PAUL C. DEAN, of Dean Brothers; vice-president, C. L. MOHR, of the Ambassador Oil Company; secretary-treasurer, WILLIAM J. HILSEWECK, of the Gulf Oil Corporation.

H. HART PRATLEY, formerly associated with United Geophysical Company and its affiliated companies, is no longer connected with these companies. He is continuing his work in adapting seismic methods to mine exploration. In some recent seismic surveys conducted underground, from drifts and stopes, the results show that the seismograph is practical and useful as a geophysical aid to ore discovery.

C. E. DOBBIN, of the United States Geological Survey at Denver, Colorado, addressed the Kansas Geological Society at Wichita, Kansas, February 4, on the subject, "The Economic Importance of Minerals in Present World Affairs."

F. H. FASH, of the Fort Worth Laboratories, Fort Worth, Texas, discussed, "New Methods of Soil Analysis," before the Houston Geological Society, February 13.

W. E. WRATHER, a former president of the A.A.P.G., is president of the Texas Geographic Society.

The Shreveport Geological Society, Shreveport, Louisiana, presented the following program on February 7. PAUL WEAVER, of the Gulf Refining Company, Houston, Texas, spoke on "Radioactivity of Sediments," and W. L. RUSSELL, of Well Surveys, Inc., Tulsa, Oklahoma, spoke on "Radioactive Logging of Wells."

JOHN S. HEROLD has changed his address from the Sun Oil Company, Dallas, Texas, to the Forest Development Company, Midland, Texas.

FRED A. DEVIN, of the Pure Oil Company, has moved from Tulsa, Oklahoma, to Box 2127, Amarillo, Texas.

HARRY W. OBORNE, of Colorado Springs, Colorado, spoke before the Rocky Mountain Association of Petroleum Geologists, at Denver, February 3, on "Paleozoic Correlations from the Rocky Mountain Front Range to the Oklahoma-Texas Panhandle."

The Lane-Wells Company has issued a bulletin of 30 pages, *Lane-Wells Electrolog*, which is a complete story of electrical logging of uncased hole. It is designed for use by oil-company field personnel and gives a description of the electrical characteristics of formations and of the different potential and resistivity curves used to make a complete well log. Typical electrolog records are shown from different oil-producing areas. Copies are available through any Lane-Wells Branch Office or by writing to Lane-Wells Company, 5610 South Soto Street, Los Angeles, California.

ACUS R. EDWARDS, of the Shell Oil Company, Inc., has been transferred from Tulsa, Oklahoma, to Wichita Falls, Texas.

E. L. FIPPS, of the Plymouth Oil Company, is situated at Mt. Vernon, Illinois.

JOSEPH M. DAWSON has opened a consulting office at 703 Court Building, Evansville, Indiana. He is connected with Wheelock and Collins, Pickens, and Porter, operating in Mississippi and other states.

A. R. DENISON, chief geologist of the Amerada Petroleum Corporation, spoke before the Tulsa Geological Society, February 3, on "The Geology and Geography of the Bermuda Islands." The lecture was illustrated with still and motion pictures.

ROBERT L. GEYER is employed in the geophysical department of the Tulsa division of the Shell Oil Company, Inc. His mail address is Box 528, Okemah, Oklahoma.

L. P. BRISTLEY, JR., of the Gulf Research and Development Company, has moved from Liberty, Texas, to Pittsburgh, Pennsylvania.

CHARLES C. BATES, of the Carter Oil Company, has moved from Tulsa, Oklahoma, to Box 324, Holdrege, Nebraska.

Officers of the Rocky Mountain Association of Petroleum Geologists, Denver, Colorado, are: president, Miss NINETTA DAVIS, 224 U. S. Geological Survey; 1st vice-president, JAMES BOYD, department of geology, Colorado School of Mines, Golden; 2d vice-president, H. E. CHRISTENSEN, The Texas Company; secretary-treasurer, DART WANTLAND, Colorado School of Mines, 927 Humboldt Street, Denver.

JOHN C. DUNLAP, formerly with the geological department of the Mene Grande Oil Company, C. A., Langunillas, Venezuela, has returned to the United States and is now working with the geological department of the Union Sulphur Company, Inc., Sulphur, Louisiana.

PAUL H. BOOTS, of the Mene Grande Oil Company, C. A., has returned from Barcelona, Venezuela, and may be addressed at Box 2038, Pittsburgh, Pennsylvania.

H. C. DAVIS, formerly with the Caracas Petrol. S. A., has returned home. His address is Route 3, Box 354B, Austin, Texas.

STUART K. CLARK, assistant chief geologist of the Continental Oil Company, Bartlesville, Oklahoma, spoke before the Tulsa Geological Society, February 16, on "Wider Well Spacing—Panacea or Delusion."

EVERETT S. SHAW expects to return to the United States in May, 1941, after completing 2½ years of geological work for the Department of Exploration, Yacimientos Petroliferos Fiscales, Buenos Aires, Argentina.

H. H. KAVELER, of the Phillips Petroleum Company, Bartlesville, Oklahoma, talked on "Reservoir Factors in Reserve Computations," before the Shreveport Geological Society, Shreveport, Louisiana, February 18.

WADE W. TURNBULL, of the Carter Oil Company, has moved from Tulsa Oklahoma, to Box 571, Eldorado, Illinois.

The West Texas Geological Society will hold its annual Spring field trip on May 10–11. The trip will be from Fort Worth to Midland. The leaders are M. G. CHENEY, V. C. PERINI, MORGAN E. ROBERTS, and GAYLE SCOTT. Plans include a meeting in Fort Worth on Friday night, May 9, with several papers and prepared discussions, and a similar meeting in Abilene on Saturday night. Those wishing to attend will please communicate with WILLIAM M. OSBORN, Box 707, Midland, in order that he may get an estimate for hotel reservations.

GORDON W. PRESCOTT, geologist for the Halliburton Oil Well Cementing Company, formerly located at Caper, Wyoming, has been transferred to Great Bend, Kansas.

JACK W. DAVIES, geologist for the Halliburton Oil Well Cementing Company, formerly located at Great Bend, Kansas, has been transferred to Corpus Christi, Texas.

F. M. GETZENDANER, of Uvalde, Texas, spoke before the South Texas Geological Society in San Antonio on the evening of February 14 on the subject, "Jurassic and Early Cretaceous Deposits in South Texas."

On Friday night, February 21, at a regular meeting of the South Texas Geological Society in Corpus Christi, Texas, L. O. KELSEY, of the Republic Natural Gas Company, spoke on "Structure of White Point and East White Point Fields." On the same program PHIL F. MARTYN and CHAS. H. SAMPLE, of the Houston Oil Company, discussed "Oligocene Stratigraphy of East White Point Field."

CHARLES H. ROW, of the Sun Oil Company, San Antonio, Texas spoke to an oil and gas law class in St. Mary's University of San Antonio, on the subject, "Rock Structure and Oil Relationships," February 14.

The United States Civil Service Commission has announced open competitive examinations to secure technologists for national defense work. Difficulty is being experienced in filling positions in such branches of technology as explosives, fuels, plastics, rubber, minerals, and textiles. Persons qualified in these branches are particularly urged to file application. The positions to be filled are in several grades with salaries ranging from $2,600 to $5,600 a year. For these grades, competitors will not have to take a written test but will be rated upon their education and experience. The duties of these higher-grade positions include the planning, conducting, and reporting of investigation or research in a specialized branch of technology; or the testing, designing, or manufacturing of the materials essential for the successful operation of an industrial plant. All applicants must have completed a 4-year college course with specialized major study, and for all but the junior grade, appropriate experience in the field of technology must also be shown. Applications will be rated as received until December 31, 1941. Further information and application forms may be obtained from the Secretary of the Board of U. S. Civil Service Examiners at any first- or second-class post office, or from the U. S. Civil Service Commission, Washington, D. C.

PAUL F. OSBORNE has resigned his position as district geologist for the Tide Water Associated Oil Company, and has opened a consulting office at 601 Citizens National Bank Building, Evansville, Indiana.

L. P. TEAS has resigned his position as chief geologist of the Humble Oil and Refining Company. MORGAN J. DAVIS, formerly Gulf Coast division geologist has been appointed his successor. Davis is replaced by H. J. MCLELLAN, geologist in the East Texas division, and E. A. WENDLANDT is appointed geologist for the East Texas division.

THOMAS C. WILSON, formerly at Pittsburgh, Pennsylvania, may be addressed at Apartado 376, Managua, Nicaraugua, Central America.

JAMES W. HUNTER has moved from Paramaribo, Surinam, to Apartado 111, Ciudad Trujillo, Republica Dominica.

CLARENCE P. DUNBAR is statistician with the Bureau of Educational Research, Alumni Hall, Louisiana State University, University, Louisiana.

A. I. LEVORSEN, chairman of the Association research committee, spoke before the Appalachian Geological Society at Charleston, West Virginia, January 24, on "Some Frontiers of Petroleum Geology."

ERNEST J. LEHNER has left the employ of the Anglo-Iranian Oil Company and is temporarily associated with the Burma Oil Company at Khodaung, Upper Burma.

The Council of the Geological Society of America, at meetings held October 26, December 25, and December 27, 1940, authorized project grants enabling the following research to go forward.

HORACE NOBLE CORYELL, Columbia University, will study bryozoans collected in the vicinity of Jeptha Knob, Kentucky, the identification of which is expected to yield conclusive information upon the correlation of beds and upon the determination of this well known structure as either a cryptovolcanic dome or a monadnock.

GEORGE P. WOOLLARD, Princeton, New Jersey, is reducing the 1003 gravity observations made during the past summer in his study of the relation of gravity and magnetic anomalies to continental structure.

CHESTER R. LONGWELL, Yale University, has been continuing field studies in the Muddy Mountains and Virgin Mountains of southern Nevada and western Arizona. He expects to clarify some of the puzzling features in the Paleozoic, Cretaceous, and Tertiary stratigraphy.

R. H. BECKWITH, University of Wyoming, will spend most of the coming summer in a detailed field study of the structure of the Upper Laramie River Valley of Colorado and Wyoming, an area of about 135 square miles and the meeting place of two major mountain ranges. The study is expected to contribute to knowledge of the genesis of Rocky Mountain structure.

HENRY C. STETSON, Harvard University and Woods Hole Oceanographic Institution, will procure spare parts for a free-fall coring tube which has been proved successful in dredging operations being carried out on the continental slope and in the Atlantic Basin.

RAYMOND E. PECK, University of Missouri, will devote August and September to study of the microfossils of fresh-water deposits scattered across Wyoming between the Black Hills and Star Valley. These rest upon various beds, from the top of marine Jurassic to the base of the Upper Cretaceous.

G. E. CONDRA, University of Nebraska, will continue studies of Pennsylvanian and Permian Bryozoa and their use in biologic and stratigraphic correlation.

JOHN T. LONSDALE, Ames, Iowa, and ROSS A. MAXWELL, regional geologist of the National Park Service, will collaborate in a study of the stratigraphy, structure, petrology, and history of the Chisos Mountains, Texas. The detailed mapping has been completed by Maxwell. Lonsdale will make a 2-month field study of the igneous rocks and collect samples for analysis by the Grout Laboratory.

HARRY H. HESS, Princeton University, will make chemical and optical studies of ten clinopyroxenes from basalts, diabases, and gabbros.

HAROLD R. WANLESS, University of Illinois, is concluding preparation of cross-section correlation diagrams for use in his report on "Pennsylvanian strata of Tennessee, Georgia, and Southern Kentucky."

ROBERT T. HILL, Dallas, will continue his studies of the history of geologic investigation in the Southwest, including identification and interpretation of the routes of Cabeza da Vaca and Coronado.

GEORGE F. YUNCK, of the Pure Oil Company, has been transferred from Clay City to Olney, Illinois.

HUBERT BALE, consulting geologist of Oklahoma City, talked on "Valuation of Oil Properties," before the Ardmore Geological Society, March 5.

WARREN B. WEEKS, of the Phillips Petroleum Company, Shreveport, Louisiana, discussed "The Geology of the Schuler Field, Arkansas, and Relationship to General Area," before the Houston Geological Society, February 27.

THOMAS A. HENDRICKS, of the United States Geological Survey, discussed "Structure of Ouachita Mountains," before the Ardmore Geological Society, last month.

RAYMOND C. MOORE, director of the Kansas Geological Survey, Lawrence, Kansas, has been elected president of the Association of American State Geologists, and ROBERT H. DOTT, director of the Oklahoma Geological Survey, Norman, Oklahoma, has been elected secretary.

GUSTAV EGLOFF, research director of the Universal Oil Products Company, Chicago, and B. B. WEATHERBY, president of the Geophysical Research Corporation, Tulsa, have been reappointed co-chairmen of the scientific committee and the Hall of Science for the International Petroleum Exposition at Tulsa in May, 1942.

GERSON H. BRODIE, who has been with the Fohs Oil Company at Houston, Texas, may be addressed at 175 Riverside Drive, New York City.

JAMES F. MICHAEL, of the Amerada Petroleum Corporation, has been transferred from Centralia, Illinois, to Box 2151, Jackson, Mississippi.

FRANK R. DENTON, East Texas district geologist for the Stanolind Oil and Gas Company, and R. M. TROWBRIDGE, East Texas district stratigrapher for the Shell Oil Company, Inc., have resigned their positions and entered into a general consulting partnership with headquarters at 225 Owen Building, Tyler, Texas.

JOHN JANOVY is with the Louisiana Land and Exploration Company, 1006 Whitney Building, New Orleans, Louisiana.

J. MARVIN WELLER and L. E. WORKMAN, of the Illinois Geological Survey, delivered a paper on "The Ordovician of Illinois," before the Illinois Geological Society, at Olney, February 21.

E. A. PASCHAL, of the Coline Oil Corporation, read a paper on "Major Tectonic Provinces of Southern Oklahoma and Their Relation to Oil and Gas Fields," before the Panhandle Geological Society at Amarillo, Texas, February 20.

D. L. NORLING, of the Shell Oil Company, Inc., has been transferred from Wichita Falls, Texas, to Wichita, Kansas.

The Oklahoma City Geological Society is planning a three-day field trip through Northwestern Oklahoma, and the Oklahoma Panhandle, beginning Thursday morning, May 29, extending through Memorial Day, Friday, May 30, and Saturday, May 31, with possibly an additional half day for further field work. CHARLES N. GOULD, of Norman, Oklahoma, and IRVING PERRINE, of Oklahoma City, will be the directors of this trip, with LESTER L. WHITING, chairman of the field trip committee. Other members of the committee are CURTIS HICKS, JOHN SANFORD, LELAND W. JONES, RALPH FILLMORE, and GRAYDON H. LAUGHBAUM. J. W. STOVALL of the University of Oklahoma, who is head of the vertebrate paleontology division of the School of Geology, will have charge of the field trip in the Oklahoma Panhandle, where a great number of bones have been excavated. In the same area there are a great many artifacts.

LINDSEY, G. MORGAN, recently with the Vickers Petroleum Company, is now connected with the Kansas division of the Indian Territory Illuminating Oil Company at Wichita, Kansas.

HAROLD S. THOMAS, consulting geologist, has moved from Oklahoma City, Oklahoma, to 218 Sharp Building, Lincoln, Nebraska.

GEORGE T. THOMAS has moved from Lubbock, Texas, to Mt. Pleasant, Michigan. He is with The Ohio Oil Company.

FRANK WALKER JOHNSON has been transferred from the Lago Petroleum Corporation, La Rosa, Venezuela, to the Standard Oil Company of Venezuela, Apartado 35, Barcelona, Venezuela. His new position is district geologist of the San Joaquin area. He replaces L. T. HART, who has been transferred to the exploration department in Caracas.

O. H. HILL, of the Shell Oil Company, Inc., has been transferred from Ardmore to Tulsa, Oklahoma.

THERON WASSON, chief geologist of The Pure Oil Company, Chicago, addressed the members of Kappa Epsilon Pi, at the University of Chicago, February 21, on "Methods in Petroleum Geology."

O. F. KOTICK, of the Tide Water Associated Oil Company, Oildale, California, is a captain in the 144th Field Artillery at Fort Lewis, Washington.

PAGE T. JENKINS, of the Carter Oil Company, has moved from Mattoon, Illinois, to Tulsa, Oklahoma.

H. B. STENZEL, of the University of Texas, at Austin, spoke before the Tulsa Geological Society, March 3, on "Surface Relationships of the Carrizo Sand of Texas."

ROSS L. HEATON, of Estes Park, Colorado, spoke on "Geology and Construction—Big Thompson Project," before the Rocky Mountain Association of Petroleum Geologists, at Denver, Colorado, March 3.

RICHARD E. KOCH has given up his former address at The Hague for the duration of the war and may now be addressed at Pangkalan Brandan, North Sumatra, Dutch East Indies.

JOE G. WILSON, formerly with The Texas Company at Fort Worth, is with The Texas Petroleum Company, Apartado 877, Bogota, Colombia.

JOHN T. ISBERG, has been transferred from Bakersfield to The Ohio Oil Company, 437 South Hill Street, Los Angeles, California.

EDWARD C. CRAM has moved his family from Colombia to Venezuela. His address is Socony-Vacuum Oil Company, C. A., Caracas, Venezuela.

H. J. MCCREADY has returned from Barranquilla, Colombia. His address is 4923 Knox Court, Denver, Colorado.

The first number of *Oil*, a new pictorial trade journal of the oil industry, edited and published at 232 Balter Building, New Orleans, Louisiana, contains a story, "Heine's Bugs," by its editor, Will Branan. It features HENRY V. HOWE, head of the School of Geology at Louisiana State University and president-elect of the Society of Economic Paleontologists and Mineralogists. The new journal contains also an article, "Modern Channels of the Mississippi River," by RICHARD JOEL RUSSELL, professor of physical geography at the University; a story, "Survives Snake-Bite to Become Ace Geologist," about HENRY N. TOLER, chief geologist of the Southern Natural Gas Company, Jackson, Mississippi; and an illustrated article, "Mississippi Geology," by WILLIAM C. MORSE, State geologist of Mississippi. DONALD GOODWILL, JR. is vice-president of The Oil Trade Journal Publishing Company which publishes *Oil* monthly.

LOUIS C. CHAPPIUS, consulting geologist and petroleum engineer of Los Angeles, California, has a short article on Peru, Chile, Argentina, and Brazil, illustrated by four photographs, in the *California Oil World*, second number of February.

FRED R. SCHROEDER is superintendent of the geological department of the Union Producing Company, Shreveport, Louisiana.

J. BEN CARSEY is Louisiana division geologist for the Humble Oil and Refining Company at Lake Charles, Louisiana; VAUGHN C. MALEY is division geologist at Midland, Texas; E. A. MURCHISON, JR. is district geologist at Hattiesburg, Mississippi.

JOSEPH M. WILSON, of the Salt Dome Oil Corporation, Dallas, Texas, talked before the Houston Geological Society, March 6, on "Geology of the South Cotton Lake Field, Chambers County, Texas."

D. A. MCGEE, of the Kerlyn Oil Company, Oklahoma City, talked on "The Geology of the Dakota Basin, North and South Dakota," before the Shreveport Geological Society, Shreveport, Louisiana, March 7.

RAYMOND C. BECKER, geologist with the Union Producing Company, has been transferred from Houston, Texas, to Shreveport, Louisiana.

W. B. SINCLAIR, of the Amerada Petroleum Corporation, has been transferred from Jackson, Mississippi, to Tyler, Texas.

ERIK THOMSEN is with the Stanolind Oil and Gas Company at Houston, Texas.

DWIGHT H. FORTINE, of the Barnsdall Oil Company, may be addressed at the Petroleum Building, Los Angeles, California.

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Regular Meetings: 7:30 P.M., Geological Room, University of Wichita, first Tuesday of each month. Visitors cordially welcomed.

The Society sponsors the Kansas Well Log Bureau which is located at 412 Union National Bank Building.

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Meetings will be announced.

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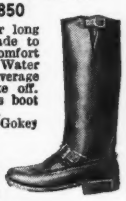

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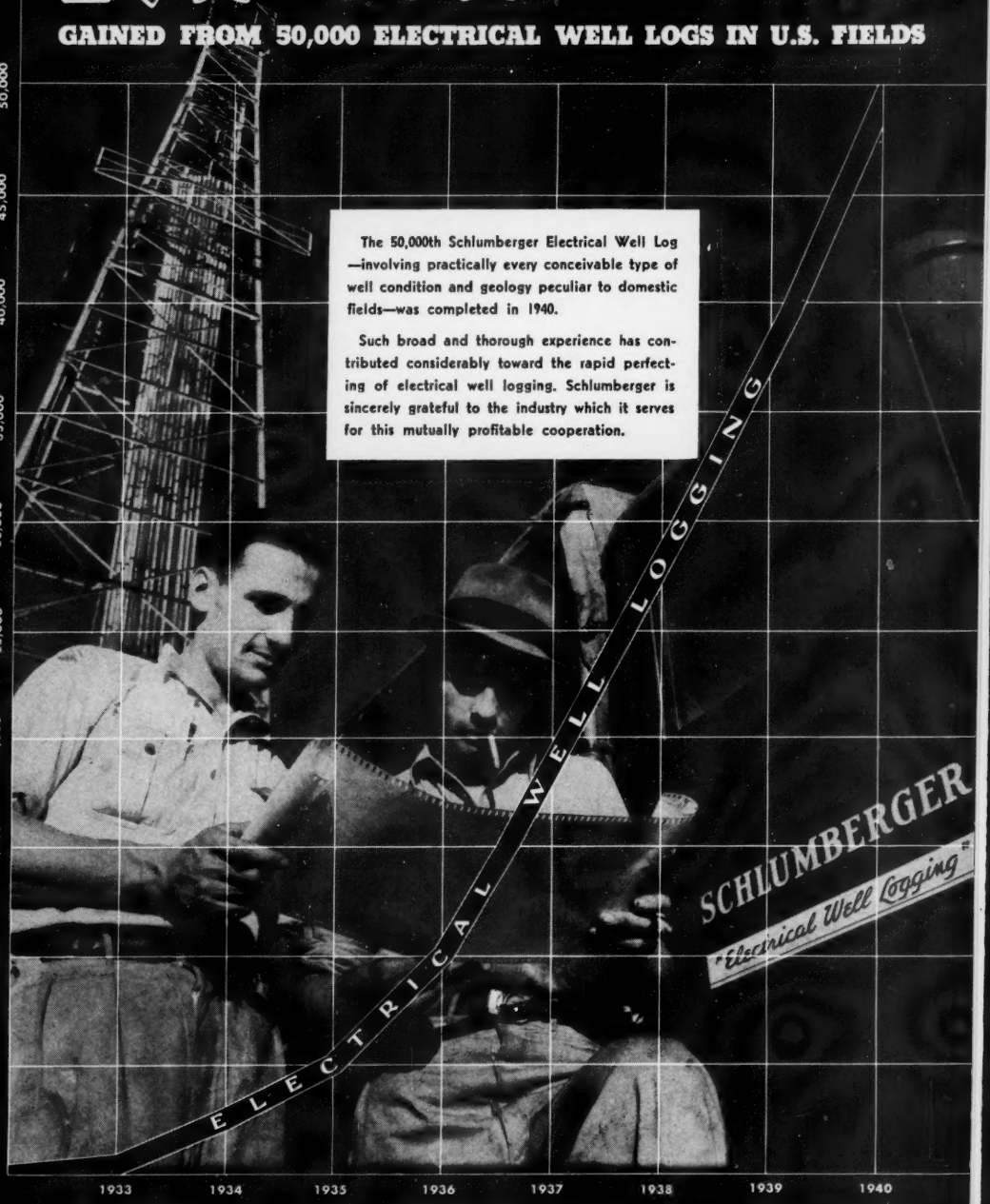

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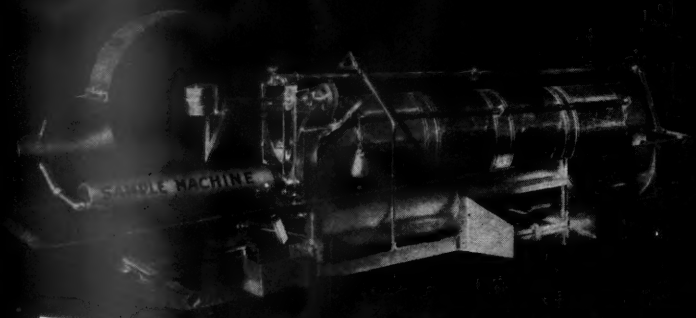

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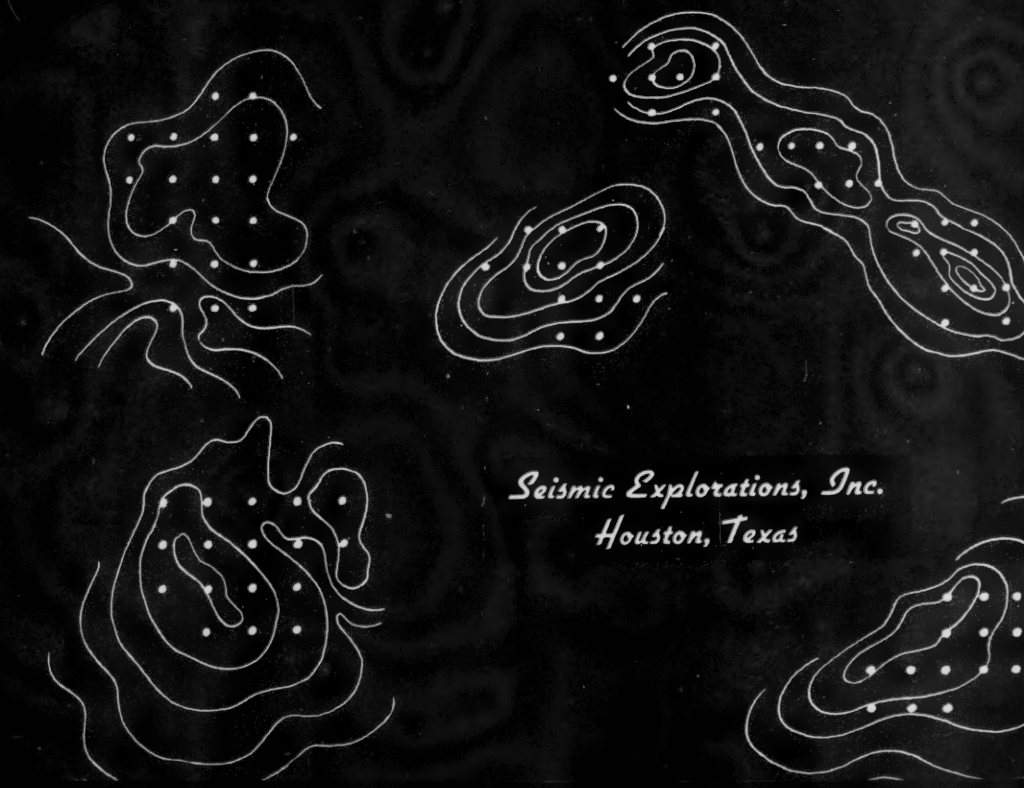

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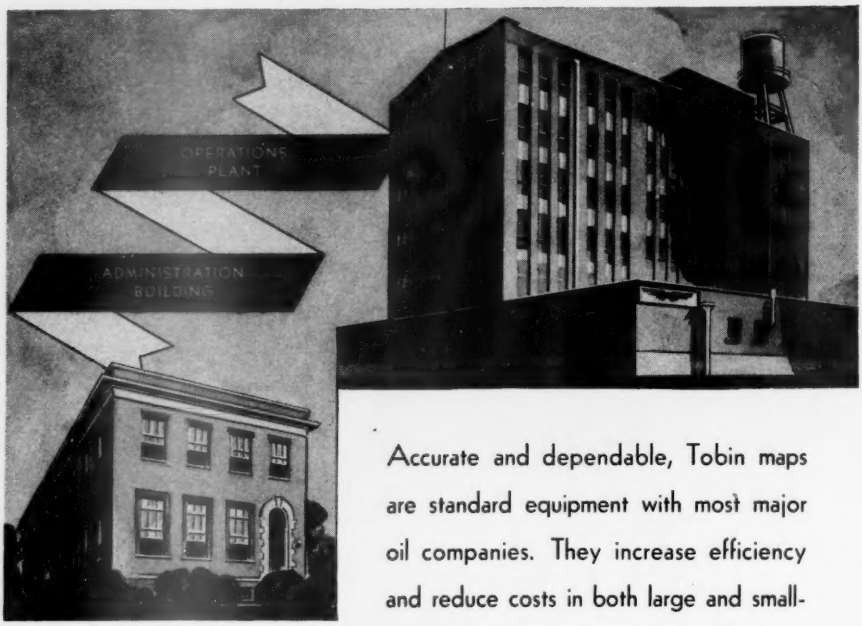

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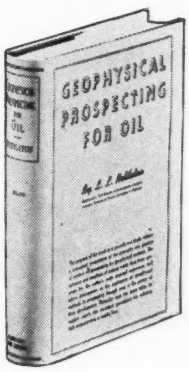

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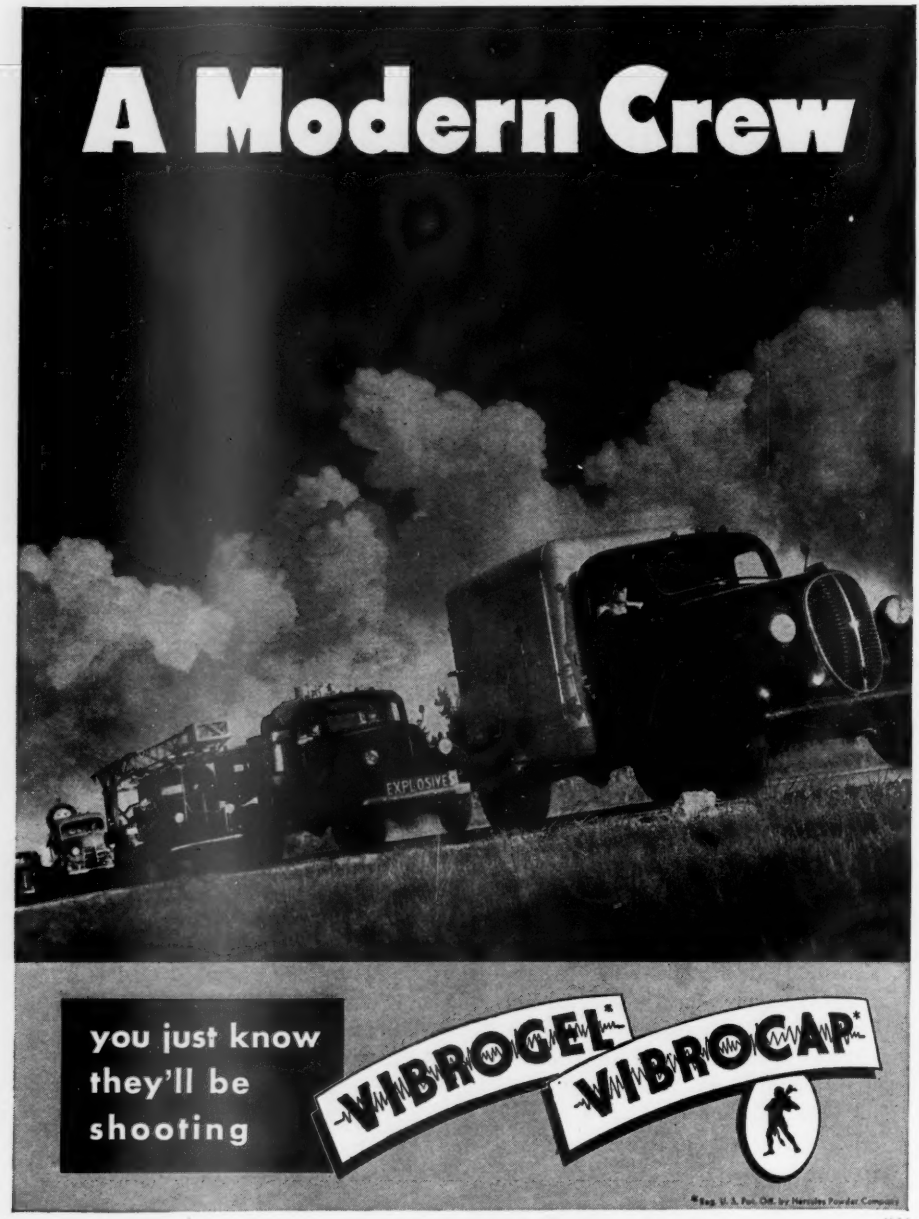

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SPECIALIZING GRAVITY SURVEYS
AND
INTERPRETATION

Under Water Gravity Meter
Surveys Now Available

CONTRACTING
CONSULTING

Foreign—Domestic

GULF BLDG.
HOUSTON, Tex.

"ROBRAY"
CABLE

COMPLETE CORING SERVICE

Hard and soft formation heads are interchangeable

THE REED "BR" WIRE LINE CORE DRILL

- For intermittent or continuous coring
- Spring loading regulates protrusion of cutter head
- Replaceable core barrel cutter heads
- Faster, more economical coring

Hard and Soft Formation Heads are interchangeable

THE REED KOR-KING CONVENTIONAL CORE DRILL

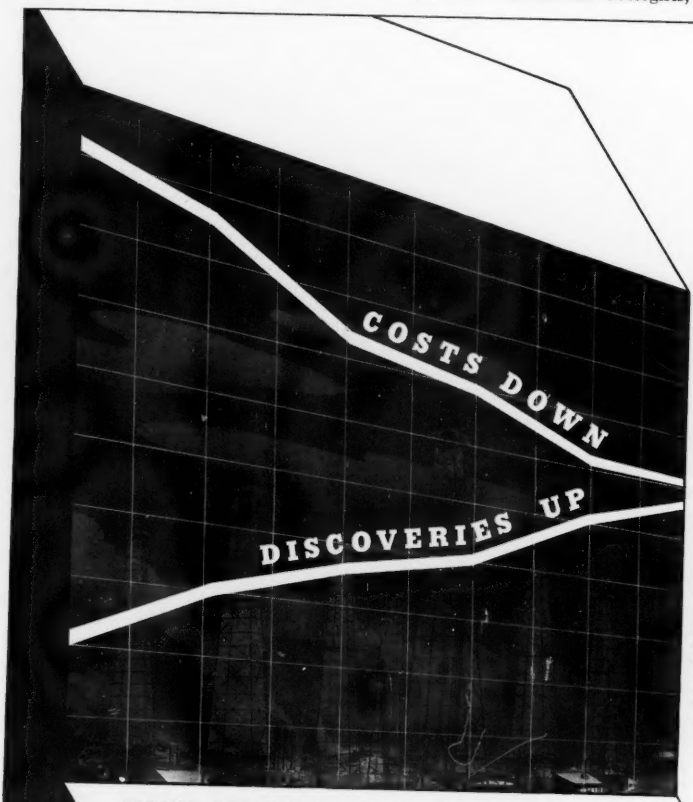
- Larger diameter cores
- Greater percentage recovery
- Non-rotating inner barrel
- Choice of inside vent, outside vent or drop ball type in the same barrel.

A CORE DRILL FOR EVERY JOB

The combined features of the Reed Wire Line and Reed Kor-King (conventional) Core Drills present an answer to every coring problem. Whether hard or soft, large or small, continuous or intermittent, in proved fields or on remote locations, a Reed Core Drill will do the job.

Outstanding performances in fields throughout the world have established Reed Core Drills as leaders in dependable, more economical coring.

REED ROLLER BIT COMPANY



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145 PRODUCING FIELDS PREDICTED PRIOR TO DRILLING!

TAKE ADVANTAGE OF OUR EXPERIENCE IN SEISMIC SURVEYS

Back of every G.S.I. report is the cumulative experience gained in mapping 145 producing fields prior to drilling.

Application of this experience has increased the percentage of discoveries and decreased their cost. Take advantage of these successes. G.S.I. is better equipped than ever before to serve you and help you reduce YOUR oil finding cost.

GEOPHYSICAL SERVICE INC.

EUGENE McDERMOTT, President

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Branch Offices: Houston, Texas – Jackson, Miss.
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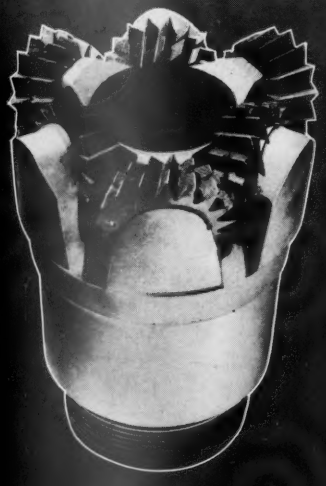
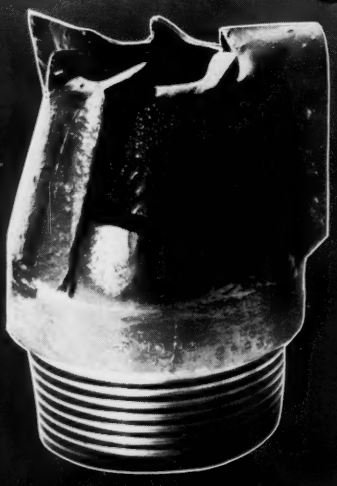
DALLAS, TEXAS

Here's why we use
HUGHES
Type 'J' CORE BITS

- Large diameter core recovered.
- Double Core Catcher---same assembly is used for both hard and soft formation coring.
- Hard and Soft Formation Cutter Heads fit the same box connection in lower end of Working Barrel --- easily interchanged for varying formations.
- Floating Core Barrel.
- Replaceable Core Barrel Tip.
- Vent for relieving pressure above core as it enters core barrel.
- Plug for keeping Core Barrel clean when running in hole.
- Ease of dressing and handling.
- Simplicity and long life of parts.
- Rugged strength of all parts for safety.





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